

# LLOYDIA

*A Quarterly Journal of Biological Science*

Published by the Lloyd Library and Museum, Cincinnati, Ohio

---

## A Synopsis of the Tribe Neocoelidini in the Americas (Homoptera-Cicadellidae)

DWIGHT M. DELONG

(Department of Zoology and Entomology, Ohio State University, Columbus 10)

The study of Neocoelidini which has led to the formulation of the present manuscript began with work upon the determination of the Mexican species, some 30 of which are known at the present time and most of which have not previously been described. After completing this portion of the study, Dr. Oman suggested the expansion of the field to include North and South American material and the inclusion of the material in the U. S. National Museum consisting of both described and undescribed species. Following his suggestion and with his assistance, the present treatment is an attempt to bring together all of the material in this group which is known and available for study. Those species not studied are listed below.

The Genus *Neocoelidia* was erected by Gillette and Baker in 1895 to include *N. tumidifrons* which they described and cited as the genotype. In 1898 Baker described the genus *Paracoelidia* and described *P. tuberculata* which he cited as the genotype. He also described in 1898 several species of *Neocoelidia*. In 1909 and again in 1916 Ball described several species of *Neocoelidia*. Oman in 1930 described *P. fusconeura*. In 1931 he described several new species of *Neocoelidia* and pointed out that with few exceptions, the male genital structures are excellent for specific separation of the North American species. In 1936 Oman described the genus *Coelidiana* and made *rubrolineata* Baker the genotype, also placing in the genus *bimaculata* Baker, *modesta* Baker, *inflata* Osborn, and *croceata* Osborn. Knull in 1942 reviewed the species of *Neocoelidia* occurring in the United States, using color markings and size as a basis for separation of the several species, and stating that the inner male genitalia were unreliable criteria for separation of several of the closely related species. A few of the species of *Neocoelidia* as here defined have similar genital structures but the species of the other genera as here defined are easily separated by the male genital structures. The genitalia of the different genera differ considerable in general form. Certain genera as I have defined them, have aedeagi with terminal accessory processes, others do not have accessory processes. The type of pygofer is also different in certain of the different genera.

Some 65 species are treated in the present synopsis and are placed in eleven genera and subgenera. These groups are separated on the basis of the type of body, type of head, and the type of male genital structures which they possess.

The food plant records have been obtained for a few species most of which seem to live on shrubs or trees. Some occur on herbaceous plants. The known food plants are in the genera *Pinus*, *Acacia*, *Rhus*, *Arctostaphylos*, and *Sphaeralcea*.

This tribe is primarily a western or southwestern group, with about half of the known species occurring in Mexico or Central America. Four species are recorded for the eastern United States and a few occur in South America.

The following South or Central American species have not been illustrated nor treated in a critical manner. *N. verecunda* Fowler from Guatemala; *N. fuscodorsata* Fowler from Guatemala and Mexico; *N. coronata* Ball from Central America and *N. crenulata* Osborn from Columbia are probably *Stenocoelidia*. Two species from Brazil, *inflata* Osborn and *croceata* Osborn apparently belong to *Coelidiana*. Three species, *punctata* Osborn from Bolivia, *ornata* Osborn from Columbia and *smithii* Baker from Brazil apparently belong to *Chinaia*.

Certain persons have assisted in the collection and loan of valuable or necessary materials for this study. Dr. Paul Oman has placed at my disposal paratype and undescribed material from the National Museum collection. Dr. R. H. Beamer has very kindly loaned certain type material from the University of Kansas collection. Several have assisted in the collection of Mexican materials. Among these are William E. Stone, John S. Caldwell, Eugene E. Good, E. W. Baker, Gilbert Shaw, John W. Balock, R. V. Hershberger, Mary Elliott, and Alfonse Dampf, to all of whom I am deeply indebted for this assistance.

As this manuscript is being completed I have just been informed of the passing of one of my former students and co-workers, Dr. Charles C. Plummer. It was his interest and influence that first took me to Mexico to study leafhoppers and without his able assistance at the times of my visits to Mexico during the past ten years, I could not have adequately obtained the material which has been used in this and other studies. I wish to acknowledge, especially my indebtedness and my appreciation, for his continued and unusual interest and assistance over the past years.

#### KEY TO GENERA AND SUBGENERA

- |                     |   |                              |
|---------------------|---|------------------------------|
| 1.                  | With a distinct carina separating the face and crown.....   | 4                            |
| 1 <sup>1</sup> .    | Without a carina between face and crown.....  | 2                            |
| 2(1).               | Small in size, short, robust, elytra scarcely covering abdomen, without a black stripe along commissure of elytra.....  | <i>Neocoelidia</i>           |
| 2 <sup>1</sup> .    | Larger in size and more elongate and slender, or if small, quite slender; elytra longer than abdomen, usually with a dark stripe along commissural line between elytra..... | <i>Stenocoelidia</i> —3      |
| 3(2 <sup>1</sup> ). | Male aedeagus with the ventral process flattened... Subgenus  | <i>Stenocoelidia</i>         |
| 3 <sup>1</sup> .    | Male aedeagus with ventral portion appearing tubular in shape.....  | Subgenus <i>Eurycoelidia</i> |
| 4.                  | Clypellus with a distinct tubercle.....   | <i>Paracoelidia</i>          |
| 4 <sup>1</sup> .    | Clypellus without a tubercle.....   | 5                            |
| 5(4 <sup>1</sup> ). | Male pygofer with a distinct spine arising on dorsal portion and with a ventral spine of some type.....   | <i>Neocoelidiana</i> —6      |



- 5'. Male pygofers with terminal spines but none arise on dorsal portion.... 8  
 6(5). Male aedeagus in lateral view appearing enlarged at apex from which arise distinct processes or teeth.....Subgenus *Neocoelidiana*  
 6'. Male aedeagus in lateral view not enlarged at apex..... 7  
 7(6'). Male aedeagus long, tapered, bifid at apex, terminating in a pair of slender, divergent processes.....Subgenus *Cocoelidia*  
 7'. Male aedeagus not bifid at apex. Processes when present arise before apex.....Subgenus *Coelella*  
 8(5'). Crown long, flat, acutely angled with front, margin appearing thin, foliaceous due to distinct carina. Pygofers very short.....*Acocoelidia*  
 8'. Crown shorter, more obtusely angled with front, and with a definite carina but not appearing foliaceous.....*Coelidiana*—9  
 9(8'). Male aedeagus with two long slender terminal processes.....Subgenus *Nelidia*  
 9'. Male aedeagus with slender apex, without terminal processes..... 10  
 10(9'). Male pygofer with ventral or terminal spines.....Subgenus *Coelidiana*  
 10'. Male pygofers elongate inflated exceeding plates by about their length, without spines.....Subgenus *Coelana*

### Genus NEOCOELIDIA Gillette and Baker

Short and robust, head definitely narrower than pronotum, apex subconical, face strongly convex. Crown convex. Forewing with a small appendix. Outer anteapical cell small and triangular or absent. Hind wing with three apical cells. Male plates fused for entire length. Pygofer with a short toothed process on ventral margin. Male aedeagus with a ventral process. The ventral aedeagus process slender, variable in length.

Type of genus *Neocoelidia tumidifrons* Gillette and Baker.

### NEOCOELIDIA TUMIDIFRONS G & B

*N. tumidifrons* Gillette and Baker, Hemip. Colo. Agri. Exper. Sta., p. 104, 1895.

A small robust species without color markings. Length 3–3.5 mm.

The crown is produced and blunt, about one-fourth wider between the eyes at base than median length.

Color: Dull yellow without distinct markings.

Genitalia: Female seventh sternite broadly truncate. The male aedeagus with a long slender phallicata. The ventral process is short and spine like in appearance; it is widely separated from the apical parallel portion of the phallicata. The pygofer is blunt apically with a short ventral spine not far from the apex.

While widely distributed, it apparently has been confused with one or more other species. It was originally described for Colorado and occurs southward and eastward from that area.

### NEOCOELIDIA VITTAPENNIS DeLong

*N. tumidifrons* var. *vittapennis* DeLong, Jour. N. Y. Ent. Soc. **32**: 55–7, 1924.

Resembling *tumidifrons* in general form and size but with color markings and distinct genitalia. Length 3–3.5 mm.

The crown is produced and blunt, almost one-third wider between eyes than median length.

Color: Dull yellow with a pair of conspicuous black spots in the basal angles of the scutellum and with dark brown longitudinal lines on the wing veins of the elytra, especially the claval suture, the costal margin, and the first and second sectors.

Genitalia: Female seventh sternite with posterior margin truncate. Male aedeagus similar to *tumidifrons* but differing by a ventral process which is composed of two parallel spines. The apical portion of the phallicata is longer than in *tumidifrons* and separated from the ventral process.

This species occurs along the Gulf coast from Florida to Texas and along the southern Atlantic coastal area.

#### ***Neocoelidia orientalis* n. sp.**

Resembling *tumidifrons* in coloration and general appearance but larger and with distinct male genitalia. Length 4–5 mm.

The crown is produced and blunt, about one-fourth wider between eyes at base than median length.

Color: Dull yellow, the claval and costal veins brown.

Genitalia: The female seventh sternite is long, the posterior margin is truncate. The male aedeagus has a phallicata with a long slender apical portion as in *tumidifrons*. The ventral process is distinctive. The base is greatly enlarged where it unites with the phallicata. The apical half is bifid forming two arms, the apex of each of which is usually bifid. The pygofer is similar to that of *tumidifrons*.

Holotype male, allotype female and male and female paratypes taken at Harrisburg, Pennsylvania, June 15, 1919 by J. G. Sanders. Male and female paratypes are also from Memphis, Tennessee, June 21, 1915; Tomah, Wisconsin, August 2, 1916; Dorain, Tennessee, June 19, 1915; and Tullahoma, Tennessee, August 3, 1915, all collected by D. M. DeLong. Paratypes from Washington, D. C., August 14, 1937, in U. S. National Museum collection.

#### ***Neocoelidia bifida* n. sp.**

A small species resembling *tumidifrons* in general appearance, but with different genitalia. Length 3.5–4 mm.

Short and broad in form. Crown blunt, conical, broader at base between eyes than median length.

Color: Pale yellow with a black spot in each basal angle of scutellum in male only. Elytra with claval suture and costal area pale brownish.

Genitalia: Female seventh sternite with posterior margin truncate, appearing slightly notched at middle. Male aedeagus with the apical half long, slender and filamentous. A short spine-like process which is bifid at the apex arises at the base of this slender portion and extends caudally.

Holotype male and allotype female collected in Colorado, 5 miles East of Old Baldy at 9000 feet elevation June 18, 1936 by Dr. E. D. Ball and now in his collection in the U. S. National Museum. Paratype male Colorado, No. 1563 in collection of C. F. Baker.

#### **NEOCOELIDIA ROMANTICA Knull**

*N. romantica* Knull, Amer. Mid. Nat. **28**: 684, 1942.

A small yellowish species with sparse reticulations on the corium of the elytra. Length 3–4.2 mm.



The crown is produced and bluntly angled about as broad between eyes at base as median length.

Color: Yellowish, crown with a black spot at apex and with longitudinal brownish vittae. Elytra creamy with reticulate nervures which are dark brown on the corium, pale on apical portion.



PLATE 1. Dorsal and lateral view of heads of type species of genera and subgenera as labeled.

Genitalia: Female seventh sternite truncate on posterior margin and slightly sinuate with a small sharp median notch. Male with an aedeagus which is enlarged before the middle and from which arises a rather long ventral process enlarged at about its middle and a dorsally directed slender process which is the apical portion of the phallicata.

This has been collected in and is recorded from the southern portion of California only.

## NEOCOELIDIA LACTIPENNIS (V.D.)

*Jassus lactipennis* Van Duzee, Ent. Amer. 6: 49-51, 1890.

*N. ramona* Ball, Ent. News 27: 206, 1916.

Resembling *tumidifrons* in general form but with distinct coloration and male genitalia. Length 3.5-4 mm.

The crown is blunt, produced, about as long at middle as basal width between the eyes.

Color: Yellowish to gray with a black spot at apex of crown and a black spot near each basal angle of the scutellum. Crown sometimes with faint linear brownish spots either side of median line. Elytra white with brown veins.

Genitalia: Female seventh sternite produced and truncate on the posterior margin. The male aedeagus has an angled enlargement on the anterior margin near the middle of the phallicata. From this arises a long slender apical portion of the phallicata and a more ventral process. These two processes are contiguous for a short distance at their bases. The ventral process is enlarged a little before the apex then slopes to a sharply pointed apex.

This species has been collected in California, Nevada, and Utah.

## NEOCOELIDIA BALLI Knull

*N. balli* Knull, Amer. Mid. Nat. 28: 685, 1942.

A small robust species without reticulations. Length 4-4.5 mm.

The crown is bluntly angled, a little wider between eyes at base than median length.

Color: Pale yellow with a black spot at apex of crown and a spot on each side of scutellum at about its middle. Crown, pronotum and scutellum marked with longitudinal vittae.

Genitalia: Female seventh sternite with posterior margin truncate or slightly excavated. The male aedeagus is enlarged before the middle by an angular protrusion on the anterior margin. From this a slender dorsal portion forms the apical portion of the phallicata and there is an equally long slender ventral portion. These two processes are contiguous at their bases.

At present it is known only from Utah and Arizona.

## NEOCOELIDIA OROVILA Ball

*N. orovila* Ball, Ent. News 27: 206, 1916.

A somewhat elongate, slender species with distinct markings. Length 4.5-5 mm.

The crown is produced, as long on middle as basal width between the eyes.

Color: Dull yellow with a black spot at apex and a black spot on each side of scutellum almost half-way from basal angle to apex. The elytra are gray or yellowish with dark brown veins.

Genitalia: Female seventh sternite with the posterior margin truncate. Male aedeagus broadened not far from base by an angularly produced portion on the anterior margin. From this arises a long slender apical portion of the phallicata and a long slender ventral process; they are contiguous at their bases.

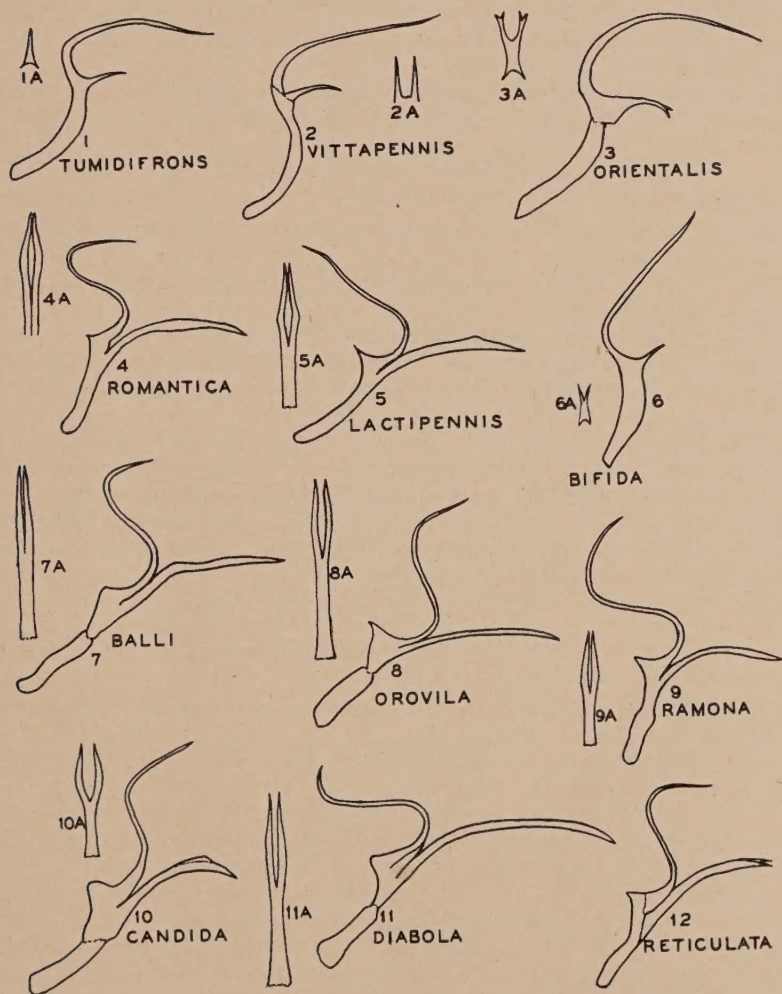
Known only from California.



## NEOCOELIDIA CANDIDA Ball

*N. candida* Ball, Ent. News 20: 166-7, 1909.

Resembling *tumidifrons* in general form but with different coloration and male genitalia. Length 4-4.5 mm.



PLATES 2, 3, 4. Lateral views of aedeagi and dorsal view of ventral processes (1a, etc.) of species as labeled.

The crown is produced and bluntly angled, a little wider between the eyes at base than median length.

Color: Dull gray, the crown with a black spot at apex. The crown is darker with a paler median line and two pairs of paler spots. The pronotum is mottled with darker areas. The scutellum with a black

spot on each side not far from the basal angle. The veins of the elytra are dark brown.

Genitalia: Female seventh sternite broadly truncate. Male aedeagus with the phallicata enlarged near the middle from which the long slender terminal portion and the ventral process appear to arise and are proximal with each other at the base. The ventral process is quite long, enlarged just before the apex then slopes on the dorsal caudal margin to a sharp pointed apex.

This species is common on sage in the western states, especially Colorado, Utah, Arizona, New Mexico, California and western Texas.

#### NEOCOELIDIA DIABOLA Knull

*N. diabola* Knull, Amer. Mid. Nat. **28**: 683, 1942.

A pale species with brownish reticulations on the elytra. Length 4.75–5 mm.

The crown is bluntly produced, about as long at middle as basal width between the eyes.

Color: Pale yellow with a black spot at the apex of crown and with two black spots on the scutellum. The crown and pronotum are marked with brown longitudinal lines which terminate on basal angles of scutellum.

Genitalia: Female seventh sternite with posterior margin almost truncate and with a slight indentation at middle. Male aedeagus enlarged before middle by a protrusion on the inner margin. From this enlargement arises a dorsal slender apical portion of the phallicata and a longer slender ventral process which is cleft on the apical half forming two long slender proximal processes.

All of the records for this species are from Arizona.

#### NEOCOELIDIA RETICULATA Ball

*N. reticulata* Ball, Ent. News **20**: 167, 1909.

This species can easily be distinguished by the reticulate veins on the elytra. Length 4 mm.

The crown is produced and blunt at apex, slightly wider between eyes at base than median length.

Color: Dull yellowish tinged with orange, a black spot at the apex of the crown and a black spot on each side of scutellum not far from the apex. The elytra are hyaline with brown reticulate veins.

Genitalia: Female seventh sternite with the posterior margin truncate. Male aedeagus with the phallicata angularly enlarged before the middle on the anterior margin. From this enlargement arises a long slender apical portion of the phallicata and a rather long straight ventral process which is broader and shorter than the apical portion of the phallicata.

Specimens of this species have been collected in California, New Mexico, Arizona, and northern Mexico.

#### Genus PARACOELIDIA Baker

Elongate, usually slender. Head about as wide as pronotum, anterior margin carinate at least on apical portion, face strongly convex. Pronotum short. Forewings long and slender, appendix small. Outer



anteapical cell absent, central and inner anteapical cells open basally. Hind wing with three apical cells. Male plates long united for their entire length.

Type of genus *P. tuberculata* Baker.

The known members of this genus live on pine.

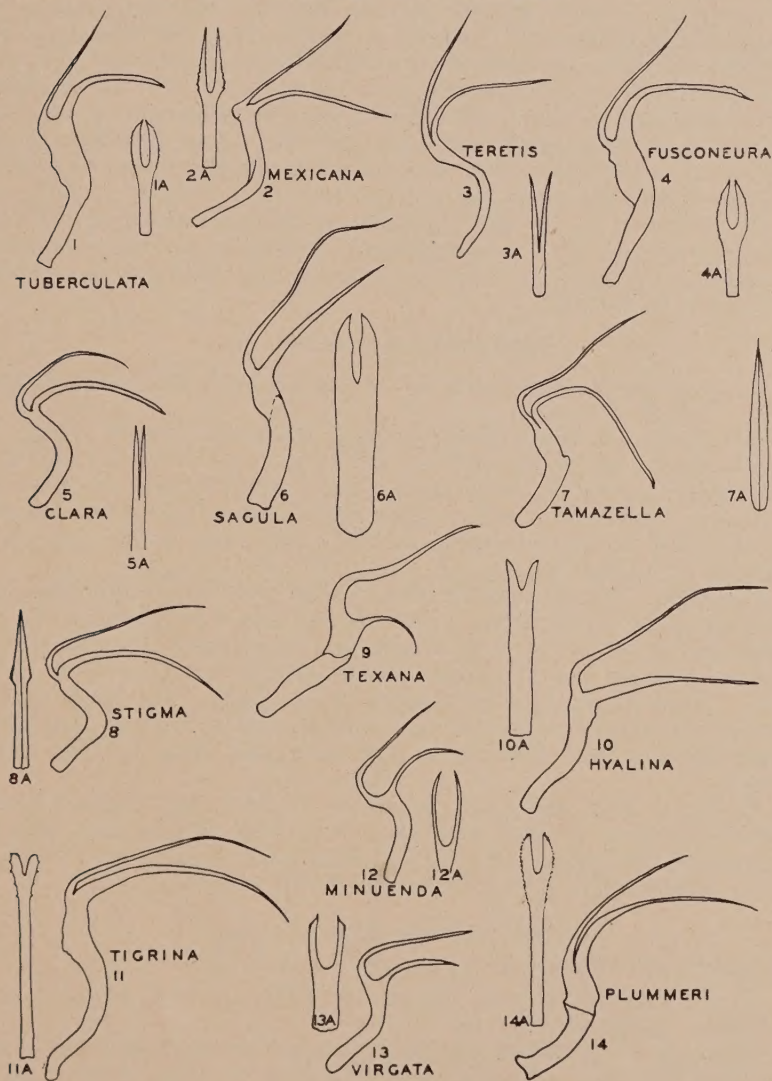


PLATE 3

PARACOELIDIA TUBERCULATA Baker

*Paracoelidia tuberculata* Baker, Can. Ent. 30: 292, 1898.

A long slender species often with a dark stripe along the commissure of the elytra. Length 6-7 mm.

The crown is well produced and bluntly angled, as long at middle as basal width between the eyes in the male, longer than basal width in the female.

Color: Yellow, without definite markings. Often the commissural line of the elytra is slightly or distinctly darker.

Genitalia: Female seventh sternite broadly, roundedly produced. Male aedeagus distinctly enlarged at middle, from the dorsal portion of which arises two processes which are decidedly separated by a rounded excavation. The dorsal process is the apical portion of the phallicata and is long and slender. The ventral portion is broader at base but tapers to a pointed apex. In ventral view the ventral process is broadened on the apical half where it is deeply roundedly excavated to form a pair of processes which are tapered and sharp pointed at the apex.

This species is somewhat variable in size and has been collected from pine in many of the eastern states. It is known to occur commonly in southern Ohio and in states east and south extending to New Jersey and south to Florida.

#### **Paracoelidia mexicana n. sp.**

A small species resembling *tuberculata* but with distinct male genitalia. Length 5-6 mm.

The crown is rather sharp pointed in female, slightly longer at middle than basal width between the eyes; blunt, almost rounded in male, length at middle about equal to basal width between the eyes.

Color: Dull yellow with a faint dark brown stripe from apex to tip of elytra, most pronounced on the commissure of the elytra and differing in intensity.

Genitalia: Female seventh sternite with posterior margin truncate. Male aedeagus a little larger on median portion of the phallicata, at the dorsal end of which two long slender processes arise. The ventral one is slightly longer than the dorsal process or apical portion of the phallicata. These fit together at an angle at the base. The apical half of the ventral process in ventral view is broadened and deeply, narrowly, roundedly notched, forming a pair of rather long pointed apical processes.

Holotype male and paratype males collected at Uruapan, Mich., Mexico, October 1, 1941; allotype female from Puebla Pue, Mexico, October 18, 1941 collected by Good, Plummer, Caldwell, and DeLong. All were taken from pine. Type in author's collection.

#### **PARACOELIDIA TERETIS Beamer**

*Paracoelidia teretis* Beamer, Jour. Kans. Ent. Soc. 9: 31, 1936.

A small species without definite markings and with distinct male genitalia. Length 5-5.5 mm.

The crown is produced and bluntly angled, shorter and more bluntly angled in the male. Median length as great as basal width in male, longer than basal width in female.

Color: Dull yellowish, tinged with orange, especially on the head.

Genitalia: Female seventh sternite with posterior margin sinuate, keeled, and appearing slightly notched at middle. Male aedeagus only slightly enlarged at the middle from which two long slender processes



arise. The dorsal process is the apical portion of the phallicata and there is a ventral portion. These are contiguous at the base. The ventral process in ventral view is slender, deeply notched forming two slender pointed diverging apical processes.

Recorded from Arizona only.

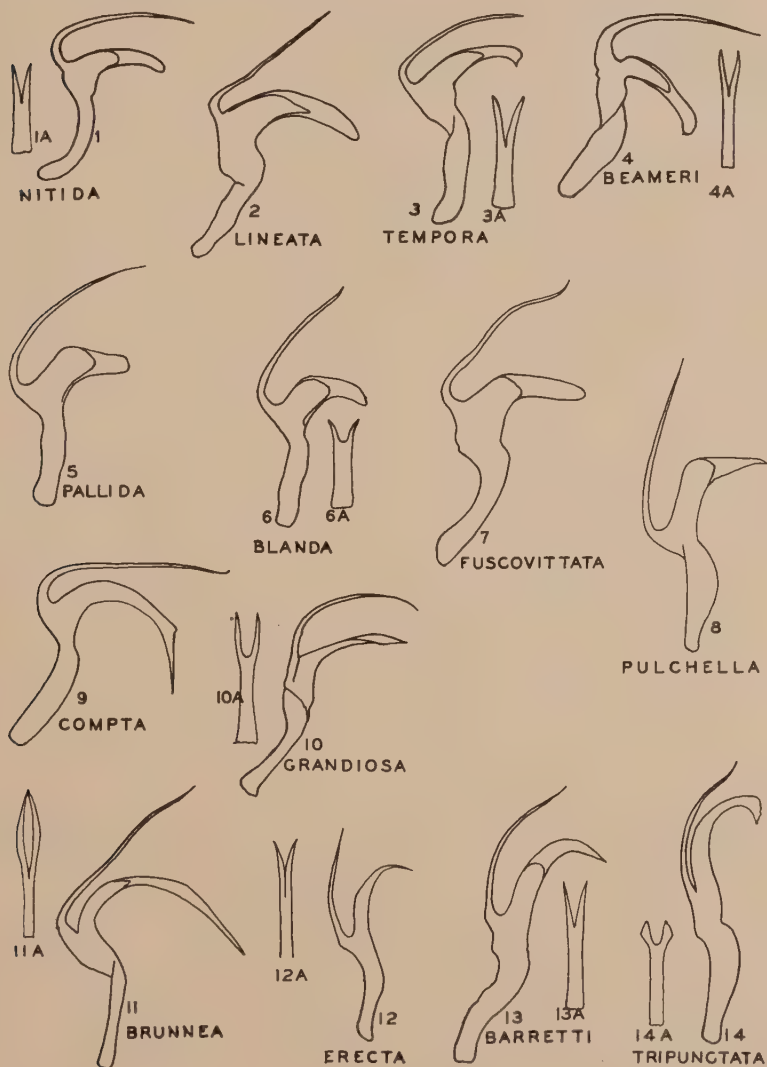


PLATE 4

PARACOELIDIA FUSCONEURA Oman

*Paracoelidia fusconeura* Oman, Jour. Kans. Ent. Soc. 3: 78, 1930.

A large blunt headed species with distinct male genital structure. Length 6-7 mm.

The crown is broad, almost truncate in male, about as long as middle as basal width between the eyes; in female more bluntly angled, the length about equalling the basal width.

Color: Dull yellow, a rather indefinite, broad brownish stripe extending from apex of crown to tip of elytra. This marking is often faint or subdued but is more prominent on the commissure of the elytra.

Genitalia: Female seventh sternite broadly roundedly produced on posterior margin. Male aedeagus with the median portion of the phallicata broadened, from the dorsal portion of which arises a long slender apical portion of the phallicata and a more thickened ventral process. The latter process is longer than the apical portion of the phallicata. It tapers toward the apex but is slightly enlarged and serrate on the upper margin just before the sharp pointed tip. These two processes are separated at the base by a rounded notch or excavation. The ventral view of the ventral process shows it is decidedly broadened on the apical half and deeply roundedly notched forming a pair of pointed processes.

At the present time this species is known to occur only in Arizona.

#### Genus *Stenocoelidia* nov.

Related to *Paracoelidia* but without a tubercle on the clypellus and without a distinct carina between the face and the crown. In some species there is a slight indication of a carina at the apex. Forewing with outer anteapical cell rather short, triangular. Central and inner anteapical cells open. Forewing with three apical cells. Pygofer with a prominent tooth on the ventral margin. Aedeagus with a prominent ventral process. The ventral aedeagus process in lateral view appearing flattened or tubular.

Type of genus *Stenocoelidia virgata* DeLong.

#### *Stenocoelidia clara* n. sp.

Resembling *barretti* in general form and coloration, but with distinct male genitalia. Length 5 mm.

Crown produced, rather blunt at apex, a little longer at middle than basal width between the eyes.

Color: Yellow with a large round black spot at apex and a large round black spot just posterior to each basal angle of scutellum which is not a part of the stripe. A dark brown to black stripe arises just back of apex on crown, is slightly broadened three times on crown and again at the posterior margin of the pronotum. It is narrowed on the scutellum and broadened on the clavus at margins of scutellum. The stripe is angularly broadened at about the middle of clavus and becomes broadest at the apex of the clavus.

Genitalia: Male aedeagus with a ventral process which is longer and a little more broadened than the slender apical portion of the phallicata. In ventral view the ventral process is rather narrow and cleft for about half its length on the apical portion forming two long slender proximal pointed processes.

Holotype male collected at Tegucigalpa, Honduras, Mar. 30, 1917 (F. J. Dyer, Col. 23297); Paratype males from La Ceiba, Honduras, Dec. 19, 1916 (F. J. Dyer, Col. 22001) and June 1, 1917 (25203). A



specimen from P. Cabello Ven, June 3, 1908, G. P. Engelhardt collection is referred to this species. Types in U. S. National Museum, paratype in DeLong collection.

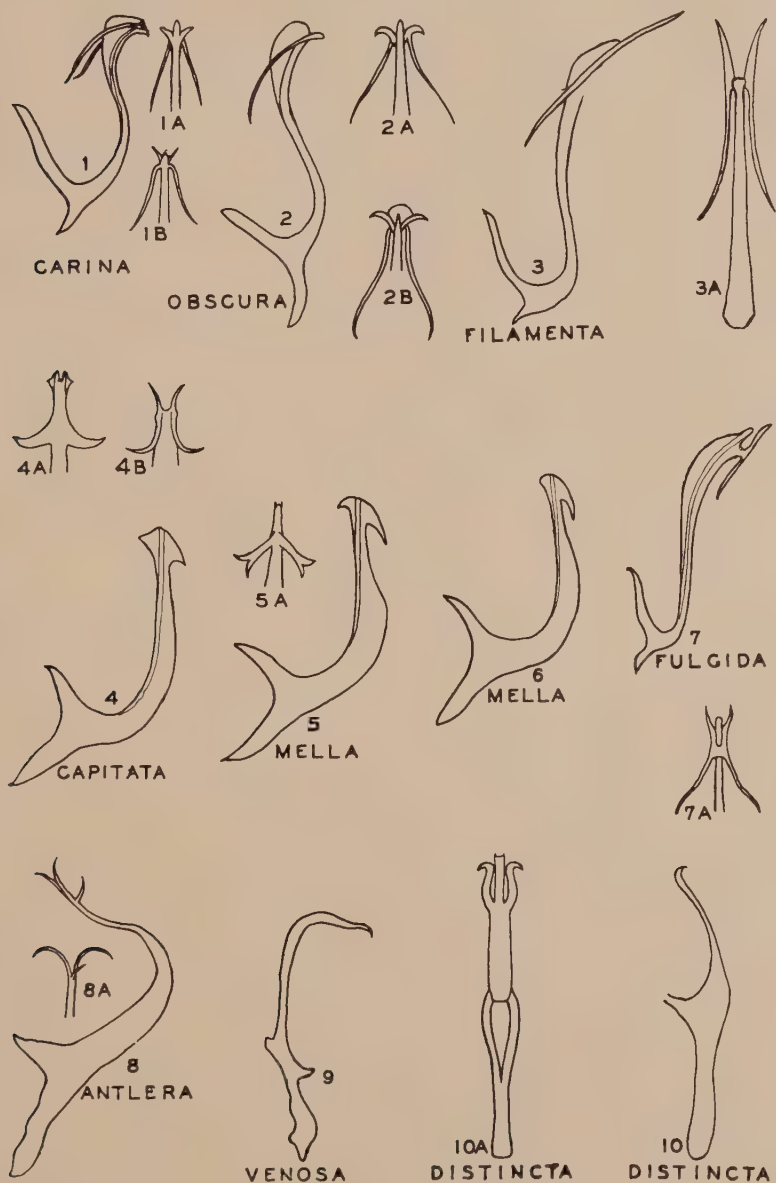


PLATE 5. Lateral views of aedeagi, ventral view of apical portion (1a, etc.), and apical view of aedeagus (1b, etc.) as labeled.

***Stenocoelidia stigma* n. sp.**

Resembling *compta* in general appearance but more narrowed with different coloration and distinct genitalia. Length 4.5–5.5 mm.

Crown is rather blunt, about as long at middle as basal width between the eyes.

Color: Dirty white to yellow with a black spot at apex. Without a median stripe or if present faint and divided medially by a longitudinal white line. Pronotum with a median brown stripe which is widened posteriorly. Scutellum with large round black spots in the basal angles. Elytra with claval vein orange. A conspicuous brown stripe extends along sutural margin which is narrowed at about the middle of the clavus and decidedly broadened at apex of clavus.

Genitalia: Female seventh sternite with posterior margin truncate. Male aedeagus rather narrow and strongly recurved on apical half. The apical half of phallicata is long and slender. The ventral process is slightly longer, more ventral and more thickened at the base. In ventral view the apical portion of the ventral process is spear shaped.

Holotype male and paratype male collected at Tehuantepec, Oax., Mexico, Oct. 13, 1941 by DeLong, Good, Caldwell, and Plummer. Allotype female from Tamazunchale, S.L.P., Mexico, Nov. 2, 1945 by DeLong, Hershberger, and Elliott. Male paratypes collected at San Miguel, El Salvador, Guat., Mar. 18, 1944 and a Puerto La Libertad, El Salvador, Guat., Mar. 22, 1944; male and female paratypes from San Salvador, El Salvador, Guat., Mar., 1942 collected by C. C. Plummer.

***Stenocoelidia tamazella* n. sp.**

Resembling *beameri* in color markings, but with distinct genitalia. Length male 5 mm.

Crown is rather blunt, as long at middle as basal width between the eyes.

Color: Yellow, the black spot at apex of crown is narrowly joined to the longitudinal black stripe which is continuous to apex of elytra. This is irregularly widened on crown from apex to base with a pair of recurved spurs at base which resemble *beameri*. The stripe on the pronotum is broad, even margined and broadened to cover almost the entire scutellum. The commissural stripe on the elytra is broad uniformly black and notched on the outer margin.

Genitalia: Female seventh sternite with the posterior margin almost truncate, slightly broadly excavated each side of the middle. The male aedeagus has a long slender apical portion of the phallicata which is longer than the basal portion and an equally long slender ventral process which is appressed to the slender portion of the phallicata basally. The ventral process is tapered and pointed at the apex as viewed ventrally.

Holotype male, allotype female and paratype male from Tamazunchale S.L.P. Mexico, collected Sept. 20, 1945 by DeLong, Hershberger, and Elliott.

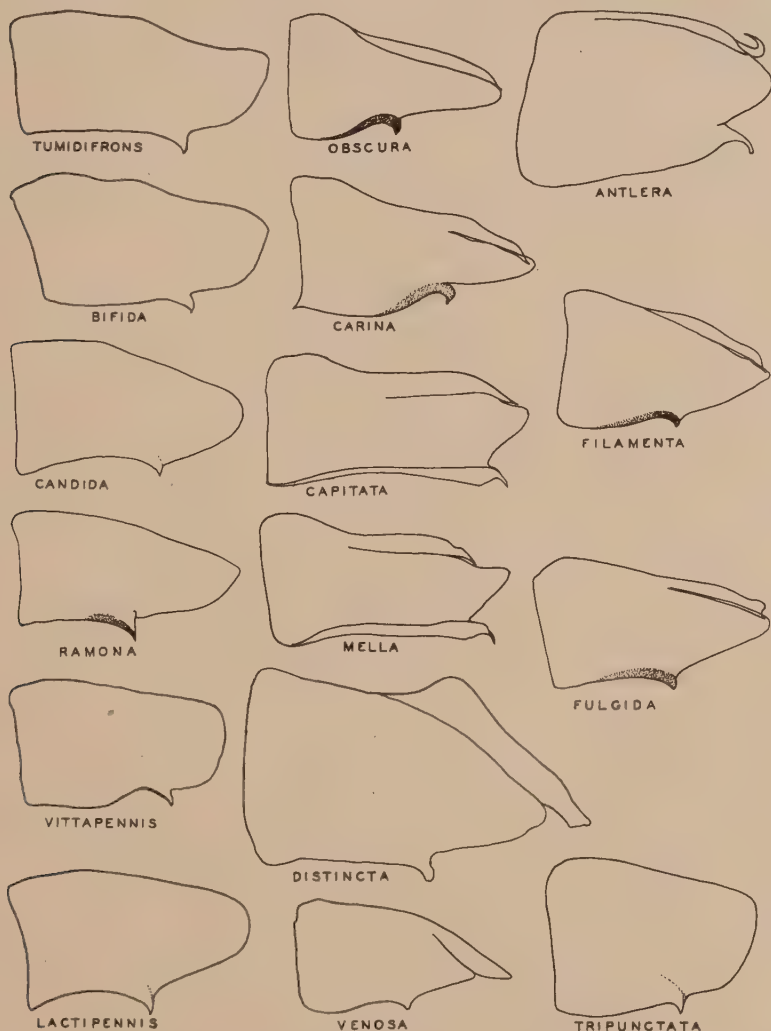
***Stenocoelidia sagula* n. sp.**

Resembling *fuscovittata* in general appearance but with distinct genitalia. Length 6.5 mm.



Crown is short and blunt, a little wider between eyes at base than median length.

Color: Yellowish, crown with a black spot at apex. A broad black longitudinal stripe extends from crown margin to apex of elytra. The



PLATES 6 and 7. Lateral views of pygofers of species as labeled showing relative position of dorsal and ventral spines.

margin of the stripe is even and the stripe is broadened to the basal width of the scutellum which is covered by the stripe. The color of the stripe is paler on the scutellum and the round black spot near the base on each side is distinguishable. The dark brown stripe on the com-

missure of the elytra is notched on the outer margin and constricted at middle of clavus. A line across margin of vertex between the eyes, the outer portions of the pronotum, and the claval veins are marked with orange.

Genitalia: The male aedeagus has a long slender apical phallicata which is longer than the straight ventral process. In ventral view, the latter process is broad, rather deeply, narrowly incised at the apex, about one-third the distance to the base. The pygofer is similar to closely related species.

Holotype male from Carapan, Mich., Oct. 2, 1941 Km 432, and paratype male from Zitacuaro, Mich., Sept. 29, 1941 Km 160 collected by DeLong, Plummer, Caldwell, and Good. Male paratype from Hidalgo, Mich., Sept. 29, 1945 collected by DeLong, Hershberger, and Elliott.

### ***Stenocoelidia hyalina* n. sp.**

A blunt headed, longitudinally striped species with unique genitalia. Length 6-6.5 mm.

Crown is very short and blunt, anterior margin almost transverse, decidedly wider between eyes at base than median length.

Color: Yellowish marked with orange brown stripes. Crown with a black spot at apex and an orange spot just before each eye on the margin. A broad orange brown band extends from apex of crown across pronotum, widening and covering scutellum. A brighter orange stripe extends from eye on each side obliquely across pronotum to base of elytron. The scutellum bears a black spot on each side near the base. The elytra appear to be hyaline with conspicuous brownish veins. A pale brownish or orange stripe on the commissure of elytra extends on claval area along scutellum to the apex of the clavus. The claval vein is broadly orange brown. The apical area of the elytra is slightly embrowned.

Genitalia: Female seventh sternite with the posterior margin broadly rounded, slightly produced. The male aedeagus has a ventral process which is a little shorter than the long terminal portion of the phallicata. In ventral view the ventral process is rather wide with a short V-shaped notch at the apex. The pygofer is more convexly curved on the dorsal apical portion than the closely related species.

Holotype male collected at Mexico City, D. F., May 5, 1944. Female paratype from Progreso Guat., collected Mar. 12, 1942 by Dr. Plummer. Male paratypes from Necaxa Pue., Mex., Oct. 27, 1945 and Jalapa Rd., Vera., Oct. 13, 1945 by DeLong, Stone, Shaw, Hershberger, and Elliott. Male paratype from El Dorado, Sina, Jan. 22, 1930 (Dampf); Female paratypes from Tasquillo Hgo., Mex., K-172 Oct. 29, 1941 (DeLong, Caldwell, and Good); Tehuantepec Oax., Mex., Oct. 13, 1941 by DeLong, Caldwell, Plummer, and Good. Female paratypes from Asuncion Mita., Guat., Mar. 27, 1942 by C. C. Plummer.

### ***Stenocoelidia tigrina* n. sp.**

Resembling *sagula* in coloration, but with distinct genitalia. Length 6-7 mm.



Crown is short and blunt, decidedly wider between eyes at base than median length.

Color: Yellow, a black spot at apex of crown. The dark stripe extending from apex of crown to tip of elytron is similar to *sagula*. It is broad and straight edged on crown and pronotum and broadened to

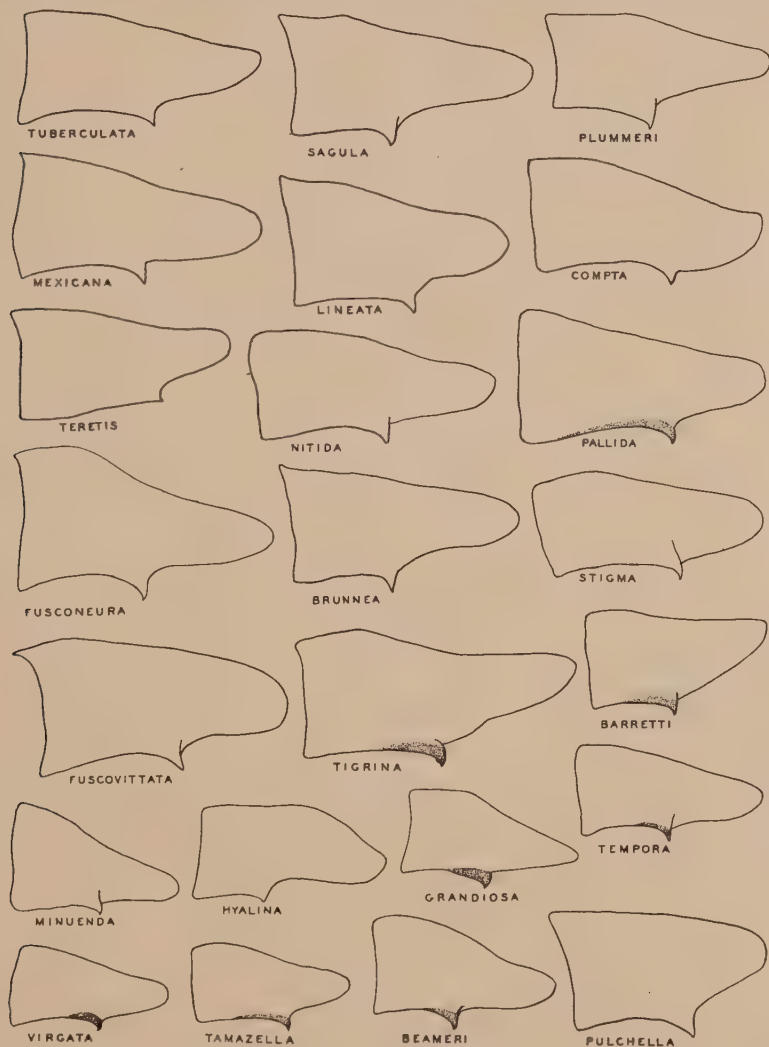


PLATE 7

almost the basal width of the scutellum. The stripe on the commissure of elytra is angularly notched on the outer margins and bordered with darker brown.

Genitalia: Female seventh sternite with posterior margin broadly roundedly produced. The male aedeagus has a ventral process which

is longer than the slender apical half of the phallicata. In ventral view the ventral process is slender gradually enlarged at the apex and slightly notched at the middle forming a pair of rounded blunt, apical, divergent processes.

Holotype male and allotype female collected at Orizaba Vera, Mexico, Oct. 10, 1941, Km. 280, by DeLong, Good, Caldwell, and Plummer.

### ***Stenocoelidia plummeri* n. sp.**

Resembling *grandiosa* in form and general appearance, but with different coloration and larger in size. Length 6-6.5 mm.

Crown is bluntly produced, about as long at middle as basal width between the eyes.

Color: White to creamy yellow. Crown with a black spot at apex, a bright orange longitudinal stripe of equal width extending from the black apical spot to the posterior margin of pronotum. Usually a bright yellow spot on the outer portion of pronotum on each side. Scutellum with a black spot on each side at middle, basal angles brighter yellow. Elytra with a pale brownish longitudinal band extending from apex of scutellum to apex of clavus where it broadens to about twice its width and extends across apical cells to clavus, completely covering the apical cells beyond the cross nervures. The band is slightly widened at the middle of the clavus and has a dark brown spot on outer margin on each side. Also where the band is widened at apex of clavus there is a faint elongate, narrow brownish spot on the outer margin on each side. Face pale, unmarked.

Genitalia: Female seventh sternite with the posterior margin broadly roundedly produced. Male aedeagus with a ventral process which is closely appressed at base to the filament-like apical portion of the aedeagus and is longer than the apical portion. In ventral view the ventral process is gradually broadened on apical third to a rounded apex which is cleft at middle about one-fifth the distance to base forming a rather broad incision which is rounded at the base. The outer edge appears serrate.

Holotype male, allotype female, and male paratype collected at Cumbro del aire Pinula, Guat., Mar. 25, 1942. Female paratypes from Jalapa, Guat., Mar. 22, 1942, all material collected by Dr. C. C. Plummer. The author takes pleasure in dedicating this species to the late Dr. Plummer.

### **STENOCELIDIA TEXANA (Oman)**

*Neocoelidia texana* Oman, Jour. Kans. Ent. Soc. 4: 62-3, 1931.

A rather long headed species with a brown stripe down the back. Length 4.5 mm.

Crown is rather strongly produced and bluntly pointed at apex, decidedly longer on middle than basal width between the eyes.

Color: Dull yellow tinted with orange yellow. Crown with a black spot at apex and a black spot on each side of scutellum just posterior to basal angle. A rather broad brown longitudinal stripe extends from area just back of apex of crown to apex of elytra. It is gradually broadened on pronotum, to include entire scutellum and is angularly broadened twice on clavus and outside of clavus at apex of clavus.



Genitalia: The male aedeagus is narrowed to form a long slender apical half which is well separated by a rounded excavation from the short slender ventral process.

This species is known only from Texas specimens.

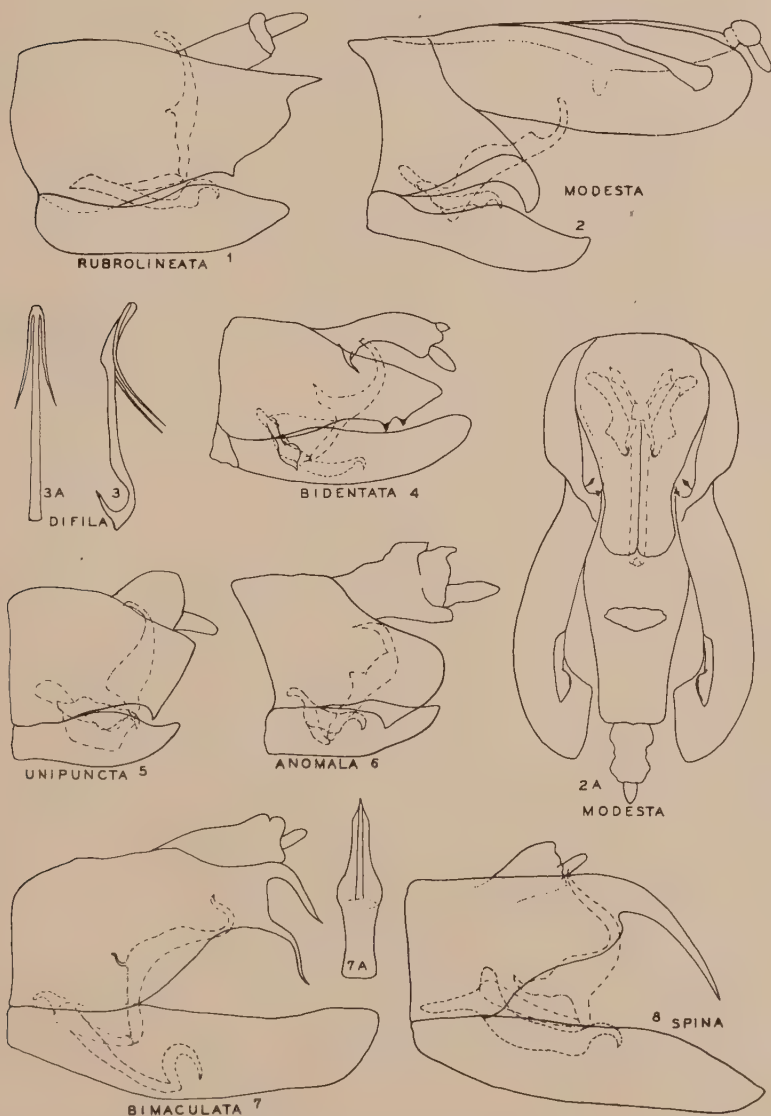


PLATE 8. Numbers 1, 2, 4, 5, 6, 7, and 8 are lateral views of terminal segments of male abdomen of species as labeled showing male genital structures in relative position; 2a—ventral view of terminal segments of abdomen of *C. modesta*; 3 and 3a—lateral and ventral views of *defila*; 7a—apical view of terminal portion of male aedeagus.

**Stenocoelidia minuenda** n. sp.

Resembling *compta* in general appearance, genital structures similar to *virgata*. Length male 4.5 mm.

Crown is rather short and blunt, a little broader at base between the eyes than median length.

Color: Yellowish, crown with a black spot at apex. A pale brownish longitudinal stripe extends from near apical spot to base of pronotum where it is broadened almost to width of base of scutellum. Scutellum pale yellowish with a black spot in each basal angle. Elytra with a broad pale brownish stripe almost as wide as scutellum extending from marginal base of clavus to apex of clavus. The outer margin is irregularly notched and dark brown bordered.

Genitalia: Male aedeagus with the dorsal phallicata portion which is slender, rather widely separated basally from the equally long ventral process. The ventral process is deeply excavated leaving what appears to be a pair of slender processes. The pygofer is not different from other closely related species.

Holotype male from Colina, Huerto Alvarez Mexico, Jan. 27, 1930 collected by Dr. Dampf.

**Stenocoelidia virgata** n. sp.

Resembling *beameri* in coloration, but with distinct male genitalia. Length 5-6 mm.

Crown is rather strongly produced, apex blunt, slightly longer at middle than basal width between the eyes.

Color: Yellowish with a dark brown or black stripe extending from apex of crown to tip of elytron. The black spot at apex is merged into an abruptly broadened stripe on crown which has three projecting points or lobes. This stripe is broadened on the pronotum to the basal width of the scutellum and covers the scutellum. The stripe on the commissure of the elytra is rather broad, irregular and dark margined on outer border. The dark coloration covers the posterior half of the apical portion of the elytron. Face yellow, unmarked.

Genitalia: Female seventh sternite with slightly produced posterior margin which is broadly rounded. Male aedeagus with the slender dorsal apical half and the ventral process rather widely separated basally. The ventral process is shorter than the dorsal portion and deeply widely excavated on the apical half. The pygofer is elongate with a short median ventral spine similar to related species.

Holotype male and allotype female collected at Cuernavaca, Mor., Mexico, Oct. 21, 1941 and Sept. 8, 1939 respectively. Male and female paratypes from Carapan, Mich., Oct. 2, 1941. Km 342 all collected by DeLong, Plummer, Good, and Caldwell. Male and female paratypes from Mexico City, D. F., June 12, 1924, and a female paratype from Colina Huerta Alvarez, Mex., Jan. 27, 1930, all collected by Dr. Dampf.

**Subgenus Eurycoelidia** nov.

Closely related to *Stenocoelidia*. Crown flattened, sometimes appearing concave, well-produced. Venation as in *Stenocoelidia*. The pronotum deeply, broadly angularly excavated on the posterior margin.



The ventral process of the aedeagus is broadened in lateral view and appears tubular. The dorsal ventral process is long and slender.

Type of genus *Neocoelidia pulchella* Ball.

***Stenocoelidia nitida* n. sp.**

Resembling *bilobata* in coloration and appearance but smaller and with distinct genitalia. Length 5-5.5 mm.

Crown is rather short and bluntly produced, about as long at middle as basal width between the eyes.

Color: Yellowish with a broad black stripe extending from apex of crown to apex of elytra. The black spot at apex of crown is merged with the anterior part of the broad black stripe which is gradually broadened to apex of pronotum to cover scutellum except small portions of basal angles. The black stripe on elytra is constricted and narrowed just beyond middle of clavus, then broadened to form its widest portion at apex of clavus.

Genitalia: Female seventh sternite with posterior margin broadly roundedly and only slightly produced. The male aedeagus is rather narrow on the basal half. It is broadened just before the base of the ventral process which is broadened throughout its length and is shorter than the long slender terminal portion of the phallicata.

Holotype male and allotype female collected at Jesus Carranza Vera., Oct. 14, 1941 by DeLong, Good, Plummer, and Caldwell.

**STENOCEOLIDIA LINEATA (Baker)**

*Neocoelidia lineata* Baker, Can. Ent. **30**: 289, 1898.

A rather large species with a subdued dark stripe along commissure of elytra. Length 6-6.5 mm.

Crown is bluntly angled, a little wider between eyes at base than median length.

Color: Pale yellow with a black spot at apex of crown and a darker stripe along commissure of elytra.

Genitalia: Female seventh sternite with a broad shallow V-shaped notch on posterior margin. Male aedeagus with a long slender apical portion which is about equal in length to the broad ventrally curved process which appears tubular in lateral view. The phallicata just beneath the junction of the ventral process is broad and thickened.

In distribution this is a northwestern species and has been taken in Washington, Oregon, Idaho, British Columbia, and parts of California.

***Stenocoelidia tempora* n. sp.**

Resembling *beameri* in general form and appearance but with different color markings and male genitalia. Length 5-5.5 mm.

Crown is produced and blunt at apex, a little longer at middle than basal width between the eyes.

Color: Yellow with a round black spot at apex. A dark brown or black stripe extends from spot at apex to tip of elytra. The stripe is widened to cover the entire scutellum enclosing the black spot at about the middle on each side. The stripe is angularly broadened

on clavus just posterior to the apex of the scutellum and again at apex of clavus where it is broadest. The face is orange, an orange stripe extends across pronotum just back of eye and the claval vein is orange.

Genitalia: The female seventh sternite is almost truncate on the posterior margin. Male aedeagus rather large at base. The apical portion is rather long and slender. The ventral process is broad at the base and gradually narrowed to form a long tubular process which is about as long as the apical portion and curves downward slightly at the apex. In ventral view it is cleft on the apical half.

Holotype male and paratype male from Tehuantepec Oax., Mexico, Oct. 13, 1941 (DeLong, Good, Plummer, and Caldwell). Allotype female and paratype female collected at Finca Vergel, Chiapas, May 15, 1935 (M.F. 4177, Dampf). Paratype males from Iguala, Gro., Mexico, Sept. 11, 1939 (Plummer and DeLong); Tamazunchale S.L.P., Nov. 2, 1945 (DeLong, Hershberger, and Elliott.)

#### *Stenocoelidia bilobata* n. sp.

A dark striped species with genital structures similar to *beameri*, but larger and with distinctive coloration. Length 5.5–6 mm.

Crown is blunt at apex, produced, about as long at middle as basal width between the eyes.

Color: White with a black spot at apex of crown, a broad brown longitudinal stripe extending from apex of crown to base of scutellum where it is broadened to width of scutellum. The sides of stripe, straight edged. A bright red stripe extends from posterior margin of each eye obliquely across pronotum. The dark stripe is divided on the scutellum by a median white line which expands to cover the apical angle. There is a round black spot on each side of scutellum near base. The dorsal stripe on the elytra is in the form of two major dark lobes. The anterior dark lobe is on the anterior half of clavus and the posterior one across apex of clavus. These are separated by a constriction of the dark pigment area just beyond the middle of clavus which extends almost to commissure line. The claval veins are reddish on basal half.

Genitalia: Female seventh sternite with posterior margin rather broadly slightly produced. The male aedeagus is rather broad on the basal half. The apical portion of the phallicata is long and slender. The ventral process is shorter and is broadened throughout its length. In ventral view it is cleft on the apical third.

Holotype male from Mexcala, Gro., Mex., Oct. 22, 1941, K 247; female allotype and paratype from Zamora, Mich., Oct. 2, 1941. Male paratypes from Tasquillo Hgo., Oct. 29, 1941, Km 172; Iguala, Gro., Oct. 25, 1941; Lake Chapala, Jal., Oct. 3, 1941 Km 610. Female paratypes from Zitacuaro, Mich., Sept. 29, 1941 and Tehuantepec, Oax. Oct. 13, 1941 all collected by DeLong, Caldwell, Good, and Plummer. Female paratype from Jalapa Rd. Vera K. 207, Oct. 13, 1945 by DeLong, Shaw, Hershberger, and Elliott.

#### STENOCELIDIA BEAMERI (Oman)

*Neocoelidia beameri* Oman, Jour. Kans. Ent. Soc. 4: 63–65, 1931.

A small species with a black stripe from apex of crown to tips of elytra. Length 4.5–5 mm.



Crown is bluntly angled, about as long at middle as basal width between the eyes.

Color: Yellowish, a black longitudinal stripe on crown which is narrow on apical portion then with three laterally produced lobes on each side. The posterior lobe is broadest and the outer portion is curved slightly forward. The stripe on the pronotum is broad and includes almost all of the scutellum. The coloration on the elytra is brown and forms a lobate longitudinal stripe on the commissure.

Genitalia: Female seventh sternite with posterior margin truncate, slightly notched at middle. Male aedeagus with the apical portion long and slender. The ventral process appears broad and tubular in lateral view and is shorter than the apical portion of the phallicata. In ventral view the two portions are divergent on the apical half.

This species was described from specimens collected in Texas and is not recorded elsewhere.

#### STENOCOELIDIA FUSCOVITTATA (Oman)

*Neocoelidia fuscovittata* Oman, Jour. Kans. Ent. Soc. **4**: 65, 1931.

A blunt headed species with a straight margined brown stripe from apex of crown to tip of clavus. Length 6-6.5 mm.

Crown is bluntly produced, in male a little wider than median length, in female about as long as wide.

Color: Yellow with a straight margined, broad, brown stripe extending from black spot at apex to tip of clavus. The stripe is gradually broadened to cover all of scutellum except the basal angles and it remains broad on the clavus. The apices of the elytra are brown.

Genitalia: Female seventh sternite broadly roundedly produced, sometimes slightly notched at apex. Male aedeagus strongly broadened at the middle from which arises a dorsal, long, slender, apical process of the phallicata and a more ventral process which is broad at the base, narrowed and produced into a thick finger-like apical portion which is blunt at the tip.

At the present time records are available for this species from New Mexico, Arizona, Texas, Colorado, Nebraska, South Dakota.

#### STENOCOELIDIA PULCHELLA (Ball)

*Neocoelidia pulchella* Ball, Ent. News **20**: 168, 1909.

A rather sharp headed species with a pale brown stripe which is sinuately margined on the clavus. Length 6-7 mm.

Crown is produced, rather sharply angled, at least one-fifth longer at middle than basal width between the eyes.

Color: Yellow with a small black spot at apex of crown. A rather broad pale brown stripe extends from apex of crown to tip of elytra. This is narrowly margined with dark brown on base of crown, portions of pronotum, scutellum, and on the angled points of the claval portion.

Genitalia: Female seventh sternite broadly roundedly produced. Male aedeagus with a short rather thick basal portion from which arises a broad ventral process which is bent sharply at about half its length with the apex bent caudo-ventrally and tapered to a sharply pointed apex.

Known to occur only in southern California.

## STENOCELIDIA PALLIDA (Baker)

*N. pallida* Baker, Can. Ent. **30**: 290, 1898.

This is a rather sharp headed yellowish species. Length 4–4.5 mm.

Crown is strongly produced and pointed. A little longer on middle than basal width between the eyes.

Color: Pale yellowish, unmarked, the crown and scutellum often paler. The crown often has faint paired longitudinal stripes of orange.

Genitalia: Female seventh sternite with the posterior margin truncate. The male aedeagus has a rather broad basal portion beyond which a broad ventral process arises which is narrowed on the apical half and deflected or bent caudo-ventrally. The apical half is composed of a long slender phallic process which arises just above and anterior to the ventral process.

This species has been collected in Arizona and the northern portion of Mexico.

## STENOCELIDIA COMPTA (Ball)

*Neocelidia compta* Ball, Ent. News **20**: 167–8, 1909.

A small species with a dorsal pale brown stripe. Length 3.5–5 mm.

Crown is blunt and about as long as basal width between the eyes.

Color: Pale with a large black spot at apex of crown and a large black spot in each basal angle of scutellum. The dorsal stripe is broad, variable in intensity of brown and angularly broadened onto clavus with outer points of triangles darker.

Genitalia: Female seventh sternite well produced, truncate on the posterior margin and with a slight notch at middle. Male aedeagus with a rather long broadened base. The apical half is long and slender. The ventral process is thickened at the base narrowed gradually to near the apex where it slopes to form a long pointed apex. The ventral process is almost as long as the dorsal apical portion of the aedeagus.

It is also a southwestern species occurring in New Mexico, Texas, Arizona, and Mexico.

## STENOCELIDIA GRANDIOSA (Knull)

*Neocelidia grandiosa* Knull, Amer. Mid. Nat. **28**: 689, 1942.

Related to *tripunctata* Ball but with distinct coloration and genital structures. Length 5.7 to 6.3 mm.

Crown is well produced, as long at middle as basal width.

Color: Yellowish white, crown with a black spot at apex and a median pale brownish stripe extending from black spot on apex to apex of clavus; a more smoky stripe continues to apex of elytra. The stripe is broadened to cover most of scutellum and again narrows on clavus. Scutellum with a round black spot on each side. The portion of the stripe just back of scutellum bordered for a short distance by darker brown. There is a dark brown dash on each side of stripe at apex of clavus. Face pale, unmarked.

Genitalia: Female seventh sternite with posterior margin appearing almost truncate, slightly notched at middle. Male plates long. The aedeagus is narrow on basal portion and broadened at the middle from which arises a rather long slender apical portion of the phallic process and a



more tubular, slightly shorter ventral process which is ventral to the terminal portion of the aedeagus. In ventral view the apical third is roundedly excavated forming a pair of separated slender apical finger-like processes.

This species was described from specimens collected in Arizona. It has been collected in Mexico at Mexico City, D. F. Sept. 26, 1945 and Oct. 20, 1945; Carapan, Mich., Oct. 2, 1941; Zacapu, Mich., Oct. 4, 1941; Desierto de Los Leones D. F. Oct. 9, 1945; Necaxa Pue, Oct. 27, 1945 and in Panajachel, Guat. Mar. 5, 1942.

***Stenocoelidia brunnea* n. sp.**

A rather short, blunt headed species rather heavily marked with brown. Length 6-6.5 mm.

Crown appearing short and blunt, a little wider between eyes at base than median length.

Color: White tinged with yellow. Crown with a round black spot at apex, a pair of median brown longitudinal stripes separated by a white line. These stripes are broadened at apex, extending either side of black spot, narrowed at base and extending across pronotum and basal half of scutellum. Pronotum with a brownish area on outer portion of scutellum behind each eye. Scutellum with a round black spot on each basal angle. Elytra pale with dark brown veins. A dark brownish spot on inner portions of clavus at base bordering the scutellum. Another brownish smoky area on posterior apical half of each elytron. Face with two broad brownish longitudinal stripes separated by a white stripe, an elongated brownish mark just above each antenna.

Genitalia: Female seventh sternite long, posterior margin almost truncate, slightly shallowly notched at middle. The entire margin rather broadly bordered with black. Male aedeagus with a slender basal portion, broadened at middle. The apical portion of the phallicata is long and slender. Ventral to it is a process which is longer than the apical structure, rather narrow and with a long tapering pointed apex. In ventral view the apical half is cleft with the halves separated at middle.

Holotype male, allotype female, and male and female paratypes collected at Zitacuro, Mich., Mexico, Sept. 29, 1941 by Caldwell, Good, DeLong, and Plummer. Paratypes were collected at Carapan, Mich., Oct. 2, 1941 by the same collectors; Jacala Hgo., Sept. 26, 1941 by Caldwell, Good, and DeLong; Cuernavaca, Morelos, Sept. 8, 1939. Mexico City, D. F., Oct. 20th and 22nd, 1945; State Border Mexico, Mich. K-139, Sept. 28, 1945 and Laguna de Zempoala, Morelos, Oct. 21, 1945 all collected by Plummer, DeLong, Hershberger, and Elliott; also at Tasquilla Hgo. K-174, Oct. 30, 1945 by DeLong, Hershberger, Elliott. Holotype, allotype and paratypes in the DeLong collection, paratypes in U. S. National Museum collection.

***Stenocoelidia erecta* n. sp.**

Resembling *beameri* in coloration and appearance, but with crown markings more intense and with distinct male genital structures. Length 5-6.5 mm.

Crown is produced and blunt, longer at middle than basal width between the eyes.

Color: Yellow tinted with orange, especially along claval suture. There is a large black spot at apex of crown and a small spot about the middle of scutellum on each side. The median stripe on crown is broad, twice deeply notched, and with the basal portion recurved to near the eyes forming a finger-like portion. The stripe is hourglass shaped on the pronotum and slightly narrowed on the scutellum. The claval portion of the stripe has three angularly widened portions on the clavus. One is at the apex of scutellum, a second enlargement is anterior to the middle, and a third is just before the apex of the clavus. The stripe is further decidedly widened outside the clavus at its apex. The inner margins of the wings at the apex are dark brown.

Genitalia: Female seventh sternite with the posterior margin broadly slightly roundedly produced. Male aedeagus appearing erect in position. The phallicata is broadened at about its middle. From this arises a long slender antero-dorsal apical portion of the phallicata and a more ventral-caudal process which is broadened at the base and is gradually tapered to a sharp pointed apex which curves caudo-ventrally.

Holotype male, allotype female and male and female paratypes collected at La Ceiba, Honduras, Oct. 11, 1916 by F. J. Dyer. Paratype male and female from Tegucigalpa, Honduras, Mar. 30, 1917 (Dyer); Female paratypes from Honduras taken on bananas at New Orleans, Baltimore and Philadelphia. Holotype, allotype and paratypes in U. S. National Museum collection. Paratypes in DeLong collection.

#### STENOCOELIDIA BARRETTI (Baker)

*Neocoelidia barretti* Baker, Can. Ent. **30**: 291, 1898.

The stripe on the crown lobed on the outer margin and lobed on claval area. Length 5.5–6.5 mm.

Crown is produced, about as long at middle as basal width between the eyes.

Color: Yellowish, the median stripe extending from the black spot at apex of crown to tip of elytra and varying in intensity of color. In some specimens the stripe is pale brown bordered with darker brown. In others, the stripe is entirely black. In each case the stripe is narrow at the apex, then broadened and forming three lobe-like portions on the outer margin on each side. The margins are irregular on both the pronotum and scutellum and on the clavus the stripe is narrowed before and behind the middle. The stripe is decidedly widened at the apex of the clavus. Scutellum with a round black spot on each side.

Genitalia: Female seventh sternite with the posterior margin slightly broadly produced, appearing almost truncate. Male plates long, tapered. The aedeagus is erect, rather broad on basal half. The apical portion of the phallicata is rather long and slender. The ventral process is thickened at base and gradually narrowed on the apical half to a sharp pointed apex which is curved caudally and ventrally. In ventral view, the apical third of the ventral process is angularly cleft forming a pair of diverging pointed, apical processes.

This species is known to occur in Mexico and Guatamala. It has been taken commonly at Tamazunchale S.L.P., Mexico in Nov., 1938 (Caldwell) and in Sept. and Nov. 1945 (DeLong, Hershberger, and Elliott.) Also taken at Valles S.L.P., Mexico, Nov., 1945 (DeLong, Hershberger, and Elliott.)

**STENOCOELIDIA TRIPUNCTATA (Ball)**

*Neocoelidia tripunctata* Ball, Ent. News **20**: 168, 1909.

A species with the dorsal stripe divided medially on the crown and pronotum. Length 6 mm.

Crown is bluntly conical, a little wider between eyes at base than median length.

Color: Yellowish with a large black spot at apex of crown. A pair of proximal faint brown stripes are on the crown and pronotum and become darker posteriorly. Scutellum with a small black spot at about middle on either side. The elytral stripe is broadest at base of clavus on each side of scutellum. Veins in male elytra broadly embrowned.

Genitalia: Female seventh sternite with posterior margin truncate or slightly emarginate. Male aedeagus rather broad on basal half, the slender apical portion of the phallicata and the equally long, but broader ventral process are erect and remain proximal to almost their apices. The ventral process is narrowed just beyond the middle then enlarged to form a blunt apex.

This species has been collected in Arizona and Texas.

***Stenocoelidia comptana* n. sp.**

Resembling *compta* in coloration, but larger and more elongate. Length 5.5 to 6 mm.

Crown is bluntly angled, width between eyes at base almost equalling median length.

Color: Pale yellow, crown with a pale black spot at apex and a median rather orange brown longitudinal stripe which extends onto and is divided longitudinally on the pronotum. Scutellum with a rather large black spot in each basal angle. Elytra with dark marks on the clavus, extending along margins of scutellum, angularly expanded near the middle of clavus and again at apex. Intensity of coloration variable.

Genitalia: Female seventh sternite broadly roundedly produced on posterior margin.

Holotype female and paratype females from Jacala S.L.P., K-314, Mexico, Sept. 22, 1945 (DeLong, Hershberger, and Elliott.) Paratype females from Tehuentepec Oax., Oct. 13, 1941 (DeLong, Caldwell, and Good.): Tasquillo Hgo., Oct. 29, 1941 and Iguala, Gro., Oct. 25, 1941 (Good and DeLong): and from near Mexico City, May 25, 1938 (MB 408) Dampf.

***Stenocoelidia goodi* n. sp.**

Resembling *erecta* in general appearance but with distinct coloration on crown. Length 5.5-6 mm.

Crown is bluntly produced, almost as long at middle as basal width between the eyes.



Color: Yellowish with the outer portions of the pronotum and the claval suture bright yellow, almost orange yellow. The crown is marked with a broad black stripe which is reduced to almost a line at apical end. The band broadens just back of apex and then is somewhat sinuately narrowed to the base where the band is slightly notched, then broadened on each side with an outwardly produced spur. The black longitudinal stripe is broad on the pronotum and covers almost the entire scutellum. It extends along the commissure, is dark brown in color, and the margins are lobate.

Genitalia: Female seventh sternite elongate, produced, with the posterior margin broadly, roundedly produced. Two female specimens which are marked alike and were taken at the same place are described at this time.

Holotype female and female paratype collected at Buena Vista Gro., Mexico, Oct. 23, 1941 by Good, and DeLong.

I take pleasure in naming this species in honor of Dr. Eugene Good.

#### ***Stenocoelidia recurvata* n. sp.**

Resembling *erecta* in general appearance but with different coloration. Length female 5 mm.

Crown is bluntly produced, a little longer at middle than basal width between the eyes.

Color: Pale yellow, crown with a black longitudinal stripe, the anterior portion of which is narrow, connecting the spot at apex. Posterior to this the stripe is broadened three times. The anterior and middle lobes on each side are small, the posterior lobe is wider and the outer portion forms a fingerlike process which curves forward more than half the length of the eye. The longitudinal stripe on the pronotum is broad, ending in a pair of black spots on the anterior margin of the scutellum. The stripe on the scutellum is narrower and separated from it is a large black spot on each side not far from the basal angles. The broad stripe on the commissure of the elytra is lobate with margins on the clavus. In *erecta* the lobes on the crown stripe are about equal in width.

Genitalia: Female seventh sternite with posterior margin almost truncate.

Holotype female collected at Acapulco, Gro., Mexico, Oct. 24, 1941 by DeLong, Good, Caldwell, and Plummer.

#### ***Stenocoelidia stonei* n. sp.**

Resembling *lineata* in coloration and general appearance, but a little larger with a blunter crown, and without a spot at apex. Length 7 mm.

Crown is blunt, rather broad on margin between eyes about as long at middle as basal width between eyes. The anterior margin is not rounded to front as in *lineata* but has a very short thin keel-like edge between the crown and front and the top of the edge is black giving it the appearance of a narrow black line extending just above margin of crown and just anterior to the ocellus on each side.

Color: Pale yellow with a broad dark brown band almost as wide

as scutellum extending from base of crown to the apex of the elytra. It also extends forward across the crown but is pale brown in color and tapers to a diffused blotch at apex. The costal marginal area is darker yellow. Face yellow.

Genitalia: Female seventh sternite with posterior margin broadly rounded appearing almost truncate with a slight median tooth which is dark brown.

Holotype female and paratype female from Tulancingo, Hdg., K-129, Oct. 25, 1945 by Stone, DeLong, Hershberger, and Elliott. Paratype female from Chilpancingo, Gro., Oct. 25, 1941 by Good and DeLong.

### ***Stenocoelidia marginella* n. sp.**

Resembling *tripunctata* in general appearance, but more slender and with distinct coloration. Length 7 mm.

Crown is bluntly produced, a little wider between eyes at base than median length.

Color: Pale yellow with a rather broad stripe extending from apex of crown to tip of elytra. The stripe on the pronotum and scutellum is longitudinally divided and on elytra it is a pale brown bordered with dark brown and is not straight on the margin. There is a black spot at apex of crown and a rather large black spot on each side of scutellum. There is an orange line extending across pronotum on each side from eye to base of claval suture and the claval suture is bright or orange yellow.

Genitalia: Female seventh sternite with posterior margin broadly roundedly produced.

Holotype female and female paratype collected at San Cristobal Las Casas Chiapas, June 6 and June 20, 1926 in pine and oak forest at the summit of Cerro de Zonlehuiz Mt., 2800 meters by Dr. Dampf.

### **STENOCOELIDIA FUSCODORSATA (Fowler)**

*Tettigonia fuscodorsata* Fowler, Biol. Amer. 2: 269, 1894.

Authentic material has not been available for study. The following description is quoted from Fowler:

"Of a light testaceous or yellow colour, with a broad dark band extending from the front to the apex of the tegmina; this band is irregular being narrowest in front and widest before and behind the middle; occasionally it is reduced in extent, head rather small, distinctly narrower than the pronotum, somewhat produced before the eyes and angled, broadly rounded in front; pronotum short, broadly sinuate at the base, with the sides rounded; tegmina smooth and rather shiny, hyaline; legs and underside light testaceous. Long. 6-7 millim; lat. vix 2 millim."

"Hab. Mexico, Juarez, (Cockerell), Amula in Guerrero, Mexico City, Vera Cruz, Teapa (H. H. Smith); Guatemala, Cerro Zunil 4000 to 5000 feet, Pantaleon (Champion)."

It would seem from my study of this group that more than one species is confused in the material cited above. Without an examination of the type specimen it seems impossible to correct the synonymy of the dark striped species at this time.

It is undoubted closely related to *texana* and *barretti*.

## STENOCOELIDIA VERECUNDA (Fowler)

*Tettigonia verecunda* Fowler, Biol. Amer. 2: 269, 1894.

Without the assistance of authentically determined material the following description is quoted from Fowler:

"A delicate, fusiform, whitish species; head produced, slightly angled a little before the eyes and then obtusely rounded in front, with two longitudinal, narrow, reddish-brown lines, which are continued, but much more broadly, on the pronotum and scutellum; pronotum very short, narrowed in front, with two broad scarlet lines at the sides; scutellum with a very conspicuous round black spot on each side; tegmina semivitreous, with the claval suture narrowly scarlet, and a few very obscure markings, but not lined, the apex slightly fuscous; underside and legs yellow.

Long. 6 millim.; lat.  $1\frac{1}{2}$  millim.

Hab. Guatemala, San Geronimo (Champion)."

*Var. cuernavacae* n.

"Agreeing exactly with the type-form in size and structure, but without the scarlet lines, and with the tegmina furnished with distinct, narrow, fuscous lines."

It is impossible to establish the identity of this species without a type specimen.

Genus *Neocoelidiana* nov.

Related to *Coelidiana*. Body elongate, crown short, blunt, face rather full, slightly inflated. A distinct carina separates the face and the crown. Forewing with a rather short outer anteapical cell. Central anteapical cell longer and usually closed. Inner anteapical cell open. Forewing with three apical cells. Male aedeagus without a ventral process, usually enlarged apically or with apical processes or both. Pygofer with a long spine-like process on the dorsal apical portion extending to apex.

Type of genus *Neocoelidia obscura* Baker.

## NEOCOELIDIANA OBSCURA (Baker)

*N. obscura* Baker, Can. Ent. 30: 289-90, 1898.

*N. pentagona* Ball, Ent. News 27: 207, 1918.

*N. triunata* Ball, Ent. News 27: 207-8, 1918.

A rather large straw yellowish species with distinct male genitalia. Length 5-6 mm.

The crown is bluntly produced with a slight ridge on upper portion of the margin, as long at middle as basal width between the eyes.

Color: Straw-yellow often with faint or pronounced orange or reddish vittae on crown pronotum and scutellum. A black spot at apex of crown.

Genitalia: Female seventh sternite with the posterior margin broadly rounded or truncate. Male aedeagus with a rather long narrow dorsal process at the base. The phallicata is long and slender, gradually enlarged at the apex to form a rounded terminal keel either side of which is a lateral ear-like process from the ventral side of which a long slender spine extends anteriorly and ventrally. The pygofer is tapered to a narrow, blunt apex with a short median ventral spine and a long



narrow dorsal spine which is just above and contiguous with the dorsal margin of the pygofer.

This is a common western species found in California, Utah, Oregon, Arizona, New Mexico, and Texas.

***Neocoelidiana carina* n. sp.**

Resembling *obscura* in general form with a dark brown spot on the commissure just back of scutellum and another at apex of clavus. Length 5-6 mm.

The crown is bluntly angled, a little wider between eyes at middle than median length.

Color: Yellowish with orange mottling on crown, pronotum, and scutellum. Elytra dull yellow, a large brown spot on base of clavus just posterior to apex of scutellum. Another dark brown spot is on apex of clavus and extends as a smoky area back to tip of elytra. Face and beneath yellowish.

Genitalia: Female seventh sternite with the posterior margin broadly roundedly produced. Male aedeagus with a long dorsally directed basal process. The phallicata is slender, narrowed at the middle and with an enlarged head like terminal portion which bears a pair of long slender apical processes which extend anteriorly and ventrally. In caudal view the apex of the aedeagus appears to have a median keel and a lateral carina on each side. The pygofer bears a long pointed dorsal apical spine resting on top of the pygofer and a short thick ventral spine at two-thirds its length.

Holotype male, allotype female, and male and female paratypes collected at Carapan, Mich., Oct. 2, 1941 (Km. 432); male and female paratypes from Taxco, Gro., Oct. 26, 1941 (Km. 150) and Sept. 9, 1939; Mexico City, D.F., Sept. 13, 1939; Tuxpan, Mich., Oct. 5, 1941 (Km. 186) Jacala, Hgo., Sept. 26, 1941; Tehuacan, Pue., Oct. 17, 1941, collected by DeLong, Plummer, Caldwell, and Good. Paratypes from Cuernavaca, Mor., Sept. 25, 1945; Necaxa, Pue., Oct. 26, 1945; Tulancingo, Hdg. (K-129), Oct. 25, 1945 and Jalapa Rd., Vera. (K-241) Oct. 13, 1945 collected by DeLong, Balock, Stone, Hershberger and Elliott. Types and paratypes in author's collection. Paratype in U. S. National Museum collection.

***Neocoelidiana filamenta* n. sp.**

Resembling *obscura* in general form and size but with different coloration and distinct genitalia. Length 5-5.5 mm.

Crown is bluntly produced, distinctly wider between eyes at base than median length.

Color: Yellowish, the crown with a black spot at apex, a transverse red band just back of apex, a spot just above each antenna. A round spot next the anterior margin of each eye and a longitudinal line extending from basal third of crown to middle of scutellum, red. There are two other red lines on each side of pronotum, one extends from eye to posterior margin and another is on the outer margin of the pronotum. These markings are faint in some specimens. The elytra are tinged with smoky.

Genitalia: Female seventh sternite, broadly, roundedly and slightly produced. Male aedeagus with a rather long slender, basal, dorsally directed process. The phallicata is narrow, gradually enlarged apically and bears a pair of long terminal processes which extend dorso-caudally and ventro-cephalically from the point of attachment. The pygofer is similar in form to those of *carina* and *obscura*.

Holotype male and allotype female collected at Chapultepec Hts., D. F. Mexico, Nov. 5, 1924 by Dr. Dampf. Female paratypes from Chapingo, D. F., March 7, 1924 and May 19, 1924 (Dampf); Mexico City, D. F., 18 Kms. west, Sept. 1, 1939 (DeLong); Baths of Netzacoayth, Mex. May 1, 1939 (Stone); and Huauchinango, Pue. Mex. Km 170, Oct. 25, 1945 by Stone, DeLong, Hershberger, and Elliott.

#### ***Neocoelidiana fulgida* n. sp.**

Resembling *filamenta* in form and general appearance but without red markings and with distinct genitalia. Length 5-6 mm.

Crown is short and blunt, slightly wider between the eyes at base than median length.

Color: Yellowish tinted with orange on crown, pronotum, and scutellum. Crown with a black spot at the apex. Face and wings yellowish unmarked.

Genitalia: Female seventh sternite with posterior margin almost truncate, slightly produced at middle and shallowly concave either side of middle. Male aedeagus with a long narrow dorsal process at base. The phallicata is narrow on basal portion and is gradually broadened on the apical half. Apex narrow and bluntly pointed. A pair of slender processes are attached to caudal margin just before the apex. They extend both dorsally and ventrally from the point of attachment.

Holotype male collected at Cuernavaca, Morelos, Mex., July 20, 1937 by W. E. Stone. Allotype female from same locality, Sept. 25, 1945 by DeLong, Plummer, Hershberger, and Elliott. Paratype male from San Jacinto, D. F., Mexico, June 17, 1929 collected by Dr. A. Dampf. Male and female paratypes collected at Iguala Gro., Mexico, Oct. 25, 1941 and Sept. 11, 1939 by DeLong, Plummer, Caldwell, and Good; Mexico City, D. F., Sept 5, 1939 (DeLong); Acapulca Gro., Mexico, Sept. 10, 1939 (Plummer and DeLong) and Mexcala Gro., Mexico, Oct. 22, 1941 (Caldwell, DeLong, Plummer, and Good.)

#### ***Neocoelidiana mella* n. sp.**

Resembling *obscura* in general appearance and coloration but with distinct genital structures. Length 7 mm.

Crown is bluntly produced, rather broad, distinctly wider between eyes at base than median length.

Color: Yellow to pale brown tinged with orange. A black spot at apex of crown and some faint orange red markings on disc of crown.

Genitalia: Female seventh sternite produced and broadly rounded, almost truncate. Male aedeagus with a short basal dorsally directed process. The phallicata is rather stout constricted just before the apical head which is usually pointed anteriorly and posteriorly. The

posterior portion is divided into two divergent arms which are bifid at the apex. The pygofer is rather long and narrowed on the apical two thirds with a bluntly pointed apex. There is a long dorsal spine, pointed at the apex which does not reach the apex of the pygofer and a longer ventral spine.

Holotype male, allotype female, and male and female paratypes collected at Iguala, Gro., Sept. 11, 1939 by DeLong and Plummer and Oct. 25, 1941 by Good and DeLong. Male paratype from Zimapan, Hgo., Sept. 26, 1941 collected by DeLong, Caldwell, and Good. Types in the author's collection.

### ***Neocoelidiana capitata* n. sp.**

Resembling *mella* in general form and coloration but with distinct genitalia. Length 7 mm.

The crown is rather short, blunt, a little wider between eyes at base than median length.

Color: Similar to *mella* yellow to pale brown tinged with orange, a black spot at apex of crown.

Genitalia: Seventh sternite with the posterior margin broadly, slightly, roundedly produced, almost truncate. The male genital structures are similar to those of *mella*. The aedeagus has a short basal dorsally directed process. The phallicata is only slightly constricted before the head-like apex which is pointed anteriorly and posteriorly. The caudal view shows the posterior portion is divided forming a curved lateral portion at each side. The pygofer is similar to that of *mella* but the dorsal spine is comparatively longer.

Holotype male and allotype female from Chapultepec Hts. D. F., Feb. 5, 1924, collected by Dr. Dampf. Paratype females from Chapingo D. F. May 19, 1924 and March 17, 1924 (Dampf); Mexico City, D. F., (Km. west) Sept. 1, 1939 (DeLong); Baths of Netzacoctl, Mex., May 1, 1938 (Stone); Huauchinango, Pue. (K-170), Oct. 25, 1945 (Stone, DeLong, Hershberger, and Elliott.)

### ***Neocoelidiana tuxpana* n. sp.**

Resembling *venosa* in general form and appearance, but with a more angularly produced crown. Length female 6 mm.

Crown angularly produced, as long at middle as basal width between the eyes.

Color: Rather bright yellow tinted with orange. The apical portion of the crown and the pronotum are tinted with orange, the veins are orange yellow.

Genitalia: Female seventh sternite with the posterior margin roundedly produced to form a blunt apex.

Holotype female and allotype female collected at Tuxpan, Mich., Oct. 6, 1941 by DeLong, Good, Caldwell, and Plummer; paratypes from Rio Tuxpan, Sept. 29, 1945; Hidalgo, Mich., Sept. 29 1945 by Plummer, DeLong, Hershberger, and Elliott; Taxco, Gro., Sept. 9, 1939 by Plummer and DeLong.

### **Subgenus *Coelella* nov.**

Related to *Neocoelidiana*. The outer anteapical cell is elongate and narrow. The middle and inner anteapical cells are open; there are



three apical cells. The aedeagus bears a pair of short lateral processes just before the apex which together are lyrate. The dorsal elongated spine-like process is on the apical half and slopes ventrally over the caudal portion with the terminal portion extending beyond the bluntly-pointed apex.

Type of subgenus *Neocoelidia distincta* Oman.

NEOCOELIDIANA DISTINCTA (Oman)

*Neocoelidia distincta* Oman, Jour. Kans. Ent. Soc. 4: 67-8, 1931.

A greenish to white species with the veins of the wings dark brown. Length 5.5-7 mm.

The crown is blunt, produced, a little wider between eyes than median length. The upper portion of the margin with a ridge or keel which is often dark brown in color.

Color: Pale yellowish-green or white with a black spot at apex of crown and wing veins dark brown. The crown, pronotum, and scutellum often with orange or brownish longitudinal vittae.

Genitalia: Female seventh sternite strongly produced, posterior margin truncate and slightly notched at middle. Male aedeagus in lateral view broadened on basal half, narrowed on apical half and slightly curved at apex. In caudal view the apical half is lyrate with a median process and not far from apex a lateral process arises on each side, extends dorsally along median process to near its apex where the tip is bent outwardly and pointed. The pygofer bears a large curious dorsal spine-like process on the apical half which rests upon the dorso-caudal portion of the pygofer and extends beyond its apex.

This distinctive species occurs in Arizona, New Mexico, and along the Mexican border in Texas.

***Neocoelidiana venosa* n. sp.**

Resembling *distincta* in general appearance, but with different genitalia. Length 5.5-6.5 mm.

Crown is rather short and broad, decidedly wider between eyes at base than median length.

Color: Dirty yellowish with a black spot at the apex of crown and a faint black line on carina of crown margin. A brown spot on each basal angle of scutellum. Elytra white subhyaline, veins brown, conspicuous.

Genitalia: Male aedeagus slender, simple in form. The base is slightly thickened just beyond which there is a short tooth-like protrusion on the caudal margin and a little beyond this a blunt tooth on the anterior margin. The apical half is slender, extends dorsally, then curves caudo-ventrally and is tapered to a narrow pointed apex.

Holotype male from Mexico City, D. F., Sept. 13, 1939; paratype male, same locality, Sept. 1, 1939, both collected by DeLong.

Subgenus ***Cocoelidia* nov.**

Related to *Neocoelidiana*. Crown flat with a distinct carina between face and crown. The male aedeagus is long, tapered, slender and bifurcate at the apex. The pygofer with a recurved spine at the end of the dorsal spine-like process and with a ventral apical spine.

Type of subgenus *Neocoelidiana antlera* n. sp.

***Neocoelidiana antlera* n. sp.**

Resembling *carina* in form but with crown, pronotum, and scutellum yellowish in color, elytra appearing dark brown or black. Length 5.5-6 mm.

Crown is produced and bluntly angled, wider between eyes at base than median length; crown with a slight keel just above margin.

Color: Crown with a black spot at apex, yellow with orange marks. Pronotum and scutellum yellowish unmarked. Elytra with a narrow yellow band along sides of scutellum, the remainder appearing uniformly dark brown to black. Face yellow tinged with pale brown.

Genitalia: Male aedeagus rather thick at base with a short basal, dorsally directed process. The phallicata tapers to a slender apex which terminates in a pair of slender diverging curved processes. There is a small dorsally directed spine just before the terminal splitting of the phallicata. The pygofer is rather broad and bears a short stout recurved dorso-caudal spine and a short straight ventro-caudal spine.

Holotype male and paratype males collected at Tuxpan, Mich., Oct. 5, 1941 Km 186 by DeLong, Good, Caldwell, and Plummer. Paratype males collected at Rio Tuxpan, Mich., Sept. 29, 1945 and at Curnavaca, Mor., Sept. 25, 1945 by Plummer, DeLong, Hershberger, and Elliott.

**Genus COELIDIANA Oman**

Elongate with wings extending beyond abdomen. Crown flat or nearly flat, distinctly raised above the eyes and separated from them by a short, perpendicular wall. Face strongly convex. Pronotum wider than head, lateral margins distinctly carinate. Forewing long and slender with one closed, elongate, triangular anteapical cell. Hind wing with three apical cells.

Type of genus *Neocoelidia rubrolineata* Baker.

**COELIDIANA RUBROLINEATA (Baker)**

*Neocoelidia rubrolineata* Baker, Can. Ent. **30**: 290, 1898.

A pale species with orange red lines on crown and pronotum. Length 6-6.5 mm.

The crown is produced and bluntly pointed about as long at middle as basal width between the eyes. The crown is produced abruptly at the eyes and the margin is separated from the front by a keel. The crown is longer than the pronotum.

Color: Buff with three distinct longitudinal orange-red lines, one at middle and one next each eye, which extend across the crown, pronotum and scutellum. A transverse orange-red band extends across the crown just back of apex connecting with the termines of the two lateral stripes. Elytra yellowish, darker along the commissure.

Genitalia: Female seventh sternite with posterior margin truncate or sinuate. Male aedeagus erect, slightly enlarged at middle, the apical portion a little more narrowed and gradually curved forward. The pygofer bears a short, sharp pointed spine on the dorsal margin. From this it slopes anteriorly to the short ventro-caudal spine.

It was originally described from Corumba and Chapada, Brazil. The U.S.N.M. types were used during this study.

## COELIDIANA BIMACULATA (Baker)

*Neocoelidia bimaculata* Baker, Can. Ent. **30**: 291, 1898.

Resembling *rubrolineata* in general form but with distinct coloration and male genitalia. Length 6–6.5 mm.

The crown is about as long at middle as basal width between the eyes at base, produced and bluntly angled.

Color: Yellow with two brown commissural spots, one on the base of clavus and one at the apex.

Genitalia: Female seventh sternite with posterior margin slightly narrowed at the apex with two long caudal spines, one on the ventral and one on the dorsal margin. The aedeagus is elongate and rather slender. The median portion is enlarged then tapered to a narrow apical recurved apex which curves forward and dorsally. The apex of the aedeagus in ventral view is simple and pointed. The style is unique with the apical portion curved like a sickle and narrow.

This species was originally described from Chapada, Brazil and is not recorded for other areas. The types have been used in this study.

**Coelidiana spina** n. sp.

Resembling *rubrolineata* in form and general appearance but with a more produced head and with distinct male genitalia. Length 6–6.5 mm.

The crown is rather sharply produced but with a bluntly angled apex, about as long at middle as basal width between the eyes, there is a narrow keel just above the anterior margin and the disc is flat.

Color: Similar to that of *rubrolineata*. The ground color is yellow with orange yellow longitudinal vittae extending from margin of crown across the crown, pronotum and scutellum. There is a median stripe and one on each side next the eye. A transverse band just posterior to apex connects the anterior ends of the lateral stripes. The elytra are yellowish subhyaline.

Genitalia: Female seventh sternite strongly, concavely narrowed on each side to form a narrow posterior margin which is broadly concavely excavated between the rounded lateral angles. Male pygofer with a long pointed spine arising on the caudo-dorsal margin and curving caudo-ventrally. The caudal pygofer margin below the base of the spine slopes rapidly anteriorly for more than half the length of the pygofer. The aedeagus is broad at base, rather abruptly narrowed at about half its length and produced as a long narrow finger like process on the apical half which is tapered and sharply pointed at the apex.

Holotype male from Tingo Maria, Peru, Sept. 15, 1944 collected from bean by E. J. Hambleton. Allotype female from Sao Paulo, Brazil, July 2, E. J. Hambleton, collector. Paratype females collected at Aguadulce Panama, Sept., 1946; Georgetown, British Guiana, Sept. 30, 1918, swept along seashore (H. Morrison) and LaBrea Tr. Oct. 18, 1918, cocoa estate by H. Morrison. Holotype, allotype, and paratypes in U.S.N.M. collection. Paratype in DeLong collection.

## COELIDIANA MODESTA (Baker)

*Neocoelidia modesta* Baker, Can. Ent. **30**: 290, 1898.

Resembling *rubrolineata* but with a shorter head and with distinct genitalia. Length 7–7.5 mm.



The crown is blunt, produced almost one-fourth wider between eyes at base than median length.

Color: Dull yellowish, crown with a minute black spot at apex.

Genitalia: Female seventh sternite broadly angularly but only shallowly excavated. Male pygofer extremely long inflated and rounded at the apex, exceeding the plates by at least their length. The aedeagus is rather broad at base narrowed at about its middle then abruptly roundedly excavated anteriorly to form an apical finger like process which is curved antero-dorsally and is blunt at the apex.

This species was originally described from female specimens from Chapada Brazil. The male allotype collected at Loreto Missiones, Arg. Dec. 3, 1931 by A. A. Ogoblin and described above is in the U.S.N.M. collection

### *Coelidiana bidentata* n. sp.

Somewhat resembling *rubrolineata* but much smaller, with a produced pointed head and with distinct genitalia. Length 5-5.5 mm.

The crown is strongly produced and angled at apex, a little longer on middle than basal width between the eyes. Disc flat, with a sharp edge on upper margin from which the face is convexly rounded.

Color: Yellowish marked with red. Crown marked similarly to *rubrolineata* with a median orange longitudinal vitta extending from apex of crown to apex of scutellum, and a lateral longitudinal vitta on each side extending from crown margin along each eye and across pronotum to the basal angle of the scutellum. A transverse band on crown connects the anterior ends of the lateral stripes. Elytra bright yellow, the posterior half of clavus slightly embrowned. The male markings are paler than in the female.

Genitalia: Female seventh sternite with the posterior margin slightly bluntly produced at the middle. Male pygofer long, decidedly narrowed on apical half and bluntly angled at apex. It bears a pair of proximal, ventral, apical teeth near apex. The aedeagus has rather prominent ventral and dorsal basal portions. It is somewhat broadened just beyond the dorsal process, then gradually narrowed and curved dorsally and anteriorly to a blunt apex.

Holotype male collected at Paso Ancho S Sebastian, Costa Rica, Oct. 4, 1936 from *Blighia sapidakon* and allotype female from Guadalupe, Costa Rica, Feb. 24, 1936, collected by C. H. Ballow. Paratype female from San Pedro de Montes de Oca, Costa Rica, Jan. 13, 1936 by C. H. Ballow and Guatemala, May 11, 1936. Holotype, allotype and paratypes in U.S.N.M. collection. Paratype in author's collection.

### Subgenus NELIDINA

Head short, narrow, crown raised above and produced before the eyes, rather broad and broadly curved anteriorly. A carina separates the crown and the front. Crown flat above, appearing bluntly angled with the front. The pronotum is broad, transverse, quite short, with posterior margin broadly slightly concavely excavated, but not angularly notched. Scutellum large, as broad as head, about as long as combined length of vertex and pronotum. First pair of wings with outer antepical cell small, elongate; middle and inner antepical cells open.

With four apical cells. Male aedeagus elongate, slender with a pair of long, slender processes arising at apex and extending caudally.

Genotype *Nelidina defila* n. sp.

***Coelidiana defila* n. sp.**

Related to *rubrolineata* but with a short head which is almost rounded in front. Length 7 mm.

The crown is short, almost one-fourth wider between eyes at base than median length; broad, almost rounded in front, with a short keel above margin.

Color: Bright yellow, almost tawny with commissural line slightly embrowned.

Genitalia: The male aedeagus is quite long and narrow. In ventral view it appears straight. In lateral view it is strongly recurved at the base. The apical fourth is slightly broadened and bent downwards and bears a pair of long slender apical processes, about one-half as long as the phallicata and which extend back upon it, being produced basally and curving ventrally.

Holotype male collected at San Ramon, Peru, June 27, 1944.

**Genus *Acocoelidia* nov.**

Related to *Coelidiana*. Elongate with forewings narrow and decidedly longer than abdomen. Outer anteapical cell elongate, triangular apical cells short. Crown flat, sloping to sharp, carinate margin which separates it from face. Head much narrower than pronotum. Crown raising perpendicularly above the eyes and produced before the eyes to form the broadly almost rounded anterior margin. Face flat, acutely angled with crown. Antennae as long as body. Pronotum short, deeply broadly angularly notched on posterior margin. Scutellum large. Pygofer short with the ventral spine at lower edge of caudal margin. Aedeagus broad at base without ventral process.

Type of genus *Acocoelidia unipuncta* n. sp.

***Acocoelidia unipuncta* n. sp.**

A yellowish species with a sharp edged margin between crown and frons and a large black spot just before cross vein of inner apical cell. Length 7.5 mm.

Crown is rather long, flat, broad on anterior portion, broadly bluntly produced in front with a sharp thin margin between the crown and front. A little wider between eyes at base than median length. Pronotum deeply notched on posterior margin.

Color: Yellow, crown, pronotum, and scutellum unmarked except for a black line on marginal keeled edge of crown. Elytra with the claval vein and the base of clavus more orange yellow. Commissure narrowly reddish. Apex of clavus with some dark brown spots and a large round black spot just before cross vein of inner apical cell.

Genitalia: Female seventh sternite with strongly produced lateral angles between which the posterior margin is rather deeply broadly excavated forming strongly produced rounded lateral lobes between which the posterior margin is broadly roundedly produced. Male plates rather short, convexly rounded to inner margin which is almost straight, forming a blunt apex, more than twice as long as width at

base. Aedeagus erect, broad at base, rapidly narrowed to about one-fourth its basal width, the narrow portion curved anteriorly at apex. Pygofer rather short and broad, posterior margin straight sided, sloping anteriorly toward the ventral side and with a short ventrally directed tooth on ventral margin partially formed by the sloping caudal margin. Styles rather short and broad, the narrowed apices curved ventrally.

Holotype male taken at Iguala, Gro., Sept. 11, 1939 by Plummer and DeLong. Allotype female and female paratype collected at Tamazunchale, S.L.P., Sept. 25, 1941 by DeLong, Good, and Caldwell. Types in the author's collection. Female paratypes from Pasa Ancho S. Sebastian C.R., Sept. 6, 1936 (Ballou) and Finca Los Cerritos, Guat., July 6, 1944 (Hambleton) July 29, 1935 and February 9, 1936 in U. S. National Museum collection.

### ***Acocoelidia anomala* n. sp.**

Resembling *unipunctata* in form and general appearance, but marked like *bimaculata* and with distinct male genitalia. Length 6 mm.

Crown is strongly produced and rounded at apex; about one-fourth longer on middle than basal width between the eyes. Margin of crown sharp, foliaceous.

Color: Crown, white washed with yellow at base. Pronotum white, tinged with yellow on disk and posterior area. Scutellum white. Elytra white tinged with bright yellow on claval and apical areas. Clavus with an elongate brown spot on anterior portion and a diagonal band across posterior portion. There is a large round black spot just before cross vein of inner apical cell.

Genitalia: The male pygofer is short and rounded at the apex with a ventral spine near the caudal portion. The aedeagus is erect with an angled tooth on the anterior margin near the middle beyond which the phallicata is broadened for a short distance. The apical fourth is abruptly narrowed, directed dorsally, curved anteriorly and sharp pointed at the apex.

Holotype male from Costa Rica, HO 12304, collected Oct. 12, 1948. Type in the U. S. National Museum.

### LITERATURE CITED

- Baker, C. F. 1898. Notes on Jassini with some new species. *Can. Ent.* **30**: 289-292.  
 Ball, E. D. 1909. Several new western Jassids. *Ent. News* **20**: 166-168.  
 DeLong, D. M. 1924. Some new Cicadellidae (Homoptera) from Southern United States. *Jour. New York Ent. Soc.* **32**: 63-69.  
 Fowler, W. W. 1894. Insects—Rhynchota Hemiptera Homoptera. *Biol. Amer.* **2**: 269.  
 Gillette, C. P. and C. F. Baker. 1895. A preliminary list of the Hemiptera of Colorado. *Bull. Colo. Arg. Exper. Sta.* **31**: 104.  
 Knull, D. J. 1942. The Genus *Neocoelidia* in the United States (Homoptera Cicadellidae). *Amer. Mid. Nat.* **28**(3): 680-692.  
 Oman, P. W. 1930. A new Paracoelidia (Homoptera—Cicadellidae). *Jour. Kans. Ent. Soc.* **3**: 78-79.  
 ———. 1931. Some new Neocoelidia with notes on other species. *Jour. Kans. Ent. Soc.* **4**: 62-68.  
 ———. 1936. A Generic revision of American Bythoscopinæ and South American Jassinae. *Bull. Univ. of Kansas* **37**: 397.  
 Osborn, H. 1923. Neotropical Homoptera of the Carnegie Museum. Part 2. *Anns. Carn. Mus.* **15**: 77-79; Parts 3 and 4. *Anns. Carn. Mus.* **15**: 449.  
 Van Duzee. 1890. New California Homoptera. *Ent. Amer.* **6**: 49-50.



# Plant Virus Studies\*

## I. Introduction

FRED A. BARKLEY\*\*

Recent years have seen a growing interest in the activity of chemotherapeutic substance and antibiotics (1) in the control of human and animal diseases, having been greatly stimulated by the discoveries of sulfonilamide and penicillin in the control of diseases due to bacteria. This interest is now reflected by the drug screening programs in progress by various research foundations and by many chemical and pharmaceutical manufacturing companies. At present the search is not only for substances that will better control bacteria, but also for substances for use against pathogenic fungi, protozoa, parasites, rickettsias, and viruses.

The ease of using the embryonated egg culture technique (2) (3) and *in vitro* growth studies make the screening of large numbers of substances comparatively simple at least with many of the viruses pathogenic to animals, in contrast to the present cumbersome methods which must be used in their evaluation in the study of plant diseases. (To the present time there has been no successful cultivation of plant viruses in embryonated eggs). The study of therapeutic substances against their activity (or toxicity) in higher plants does not have the economic attractiveness that a substance would have in relation to a human pathogen, although the weedkilling substances apparently would indicate that they might be worthy of commercial exploitation.

In the animal the introduction of the material by mouth or injection and the comparative importance of each individual of a population make a different economic picture in visualizing production of therapeutic substances, as compared to the plant where the introduction of the material into the plant body and individual member of the plant population (ordinarily) are not worthy of individual treatment.

However, apart from the practical considerations involved, any substance inhibiting growth of plant viruses would be of theoretical importance, and probably some method could be found for its practical application. Notwithstanding the more difficult problems involved at present, the comparatively minor economic reward, and the probable difficulties of applying such theoretical findings, the present interest in antibiotics and chemotherapeutic substances has initiated many facets of the study in relation to toxicity and plant disease, from the protective mechanism and antibiotic production of higher plants (4) (5) (6), the antibiotic effects of various substances in the protection of plants (7) and their seeds (9), to the effect of substances on the plant (10). The

---

\*Work carried out on grants from the Lasdon Foundation of New York and the Tropical Research Foundation of Chicago at the Department of Agriculture, Hope, Jamaica.

\*\*Present address: Microbiology Department, Nepera Chemical Co., Yonkers, N. Y.

effect of such substances on the viruses has also interested some workers (11) (12) (13). Undoubtedly the future will see much momentum toward additional studies and refinement in the methods of obtaining information about the activity of therapeutic substances on the growth of plants.

The method of introduction of the substances into the plant is one of the more difficult problems involved in studies of the effects of substances on the growth of plants and on their contained diseases. Excised portions of infected plants (10), wick methods for the introduction of the substances into the plant (12) (15), and the absorption through roots (in the present series of studies) are means of introducing substances into the plant. None of these would be practical for the treatment of plants, where the material must be absorbed directly from spraying or must be sufficiently stable to remain in the soil sufficient time for root absorption.

#### REFERENCES

1. Waksman, S. A. What is an antibiotic or antibiotic substance? *Mycologia* **39**: 565-569. 1947.
2. Goodpasture, E. W., A. M. Woodruff and G. J. Buddingh. Vaccinial Infection of Chorioallantoic Membrane of Chick Embryo. *Amer. J. Path.* **8**: 271. 1932.
3. Cox, H. R. Use of the Yolk Sac of Developing Chick Embryo as Medium for Growing Rickettsiae of Rocky Mountain Spotted Fever and Typhus Groups. *Publ. Hlth. Rep. Wash.* **53**: 2241. 1938.
4. Carleson, H. J., H. D. Bissell and M. G. Mueller. Antimalarial and Antibacterial Substances Separated from Higher Plants. *J. Bact.* **52**: 155-168. 1946.
5. Carleson, H. J., and H. G. Douglas. Screening Methods for Determining Antibiotic Activity in Higher Plants. *J. Bact.* **55**: 616-621. 1948.
6. Bishop, C. J., and R. E. MacDonald. A Survey of Higher Plants for Antibacterial Substances. *Canad. J. Bot.* **29**: 260-269. 1951.
7. Katznelson, H., and M. D. Sutton. Inhibition of Plant Pathogenic Bacteria *in vitro* by Antibiotics and Quaternary Ammonium Compounds. *Canad. J. Bot.* **29**: 270-278. 1951.
8. Gupta, B. M., and W. C. Price. Production of Plant Virus Inhibitors by Fungi. *Phytopathology* **40**: 642-652. 1950.
9. Wallen, V. R., and Skolko, A. J. Antibiotic XG as a Seed Treatment for the Control of Leaf and pra Spot of pear caused by *Ascochyta pisi*. *Canad. J. Bot.* **28**: 623-626. 1950.
10. Anderson, H. W., and I. Nienow. Effect of Streptomycin on Higher Plants. *Phytopathology* **37**: 1. 1947.
11. Leben, C., and R. W. Fulton. The Inhibition of Virus Symptom Expression by Sodium Azide, Potassium Cyanide and two Antibiotics. *Phytopathology* **41**: 23. 1951.
12. Beale, H. P., and C. R. Jones. Virus Diseases of Tobacco Mosaic and Potato Yellow Dwarf not Controlled by Certain Purified Antibiotics. *Contr. Boyce Thompson Inst.* **16**: 395-407. 1951.
13. Leben, C., and R. W. Fulton. Effect of Certain Antibiotics on Lesion Production by two Plant Viruses. *Phytopathology* **42**: 331-335. 1952.
14. Hall, E. A., F. Kavanagh and I. N. Asheshov. Action of forty-five Antibacterial Substances on Bacterial Viruses. *Antib. & Chemoth.* **1**: 369-378. 1951.
15. Roberts, W. O. Simplifications of the Roach Method of Diagnostic Plant Injection. *Jour. Pomol. & Hort. Sci.* **22**: 184-188. 1946.

The writer is indebted to the Tropical Research Foundation of Chicago, the Lasdon Foundation of New York and the Department of

Agriculture of Jamaica for the time and facilities for making these tests, to Drs. Oscar Felsenfeld, E. J. Gregory, and Mae Young for counsel and assistance during the tests.

## II. Attempt at Cross Infection between Bean and Mallow Mosaic

In Jamaica the garden bean is badly affected by mosaic, so badly so that the crop is greatly decreased, the individual plants being so badly affected that they produce almost no crop. It is known that when plants infected with bean mosaic do produce seed the seeds carry the mosaic. However, by rogueing the plants as they become infected, seeds which are virus-free may be obtained. Although when such seeds are planted in isolated locations such as flower pots, and protected, they do not develop plants with mosaic, garden plantings usually show plants developing the disease. This would indicate that either the virus is present but masked or that it is carried to the plant from some natural reservoir. Since the common mallow or broom weeds are usually present in most situations in Jamaica where beans are grown and the majority of the plants show strong mosaic infections, an attempt was made to test for cross infection between the plants as a possible reservoir of infection for the bean plants.

For the study the common garden bean (*Phaseolus vulgaris* L.) and the broom weed (*Malvastrum corchorifolium* Britt. & Small) were used. Four beans were planted in each of three flower pots. Four young plants of the broom weed were placed in each of three 250 cc. bottles of nutrient solution.

Leaves of mosaic beans were ground and the juice extracted. The leaves of the bean seedling in one pot were scratched and some of the juice placed on the fresh scratches. None of the four developed mosaic, but on the repeat one seedling developed mosaic. Two cc. of the juice was placed in one of the bottles of nutrient solution<sup>1</sup> with the broom weeds. After half an hour the plants were planted in flower pots. Two of the four mallow plants developed mosaic. On repetition only one of the four mallow plants developed mosaic.

Leaves of broom weeds infected with mosaic were ground and the juice expressed. (Little sap is produced and this is very mucilaginous). Leaves of the bean seedlings in one pot were scratched and some of the juice placed on the fresh scratches. None of the four developed mosaic nor did any of the four when it was repeated. Two cc. of the juice were placed in one of the bottles of nutrient solution with the broom weeds. After half an hour the plants were planted in flower pots. None of the broom weed plants developed mosaic nor upon repetition of the test did any of the broom weeds develop mosaic.

The four bean unscratched and used as controls and the four broom-weeds not treated with juice from infected plants did not develop mosaic. Likewise, when the tests were repeated the controls did not develop mosaic.

There is a possibility that there is a masked mosaic, for in one plant

<sup>1</sup>The nutrient solution is composed of 8 gms. of calcium nitrate, 2 gms. of potassium nitrate, 2 gms. of potassium acid phosphate, 2 gms. of magnesium sulphate and a trace of ferric phosphate per ten liters of water.



of broom weed (of four) placed in a 250-cc bottle of nutrient solution and two cc. of allantoic fluid from a chicken embryo (which had died from Newcastle disease) and then planted a half hour later, later developed a series of lightly chlorotic areas in the newly developing leaves simulating a light mosaic.

From this series of tests it seems probable that the bean and mallow mosaics are cross infectious, although much additional work would need to be done to prove this beyond question of a doubt. The writer, from his observations, has no explanation as to the vector transmitting the infectious material between plants.

### III. Toxicity of Some Substances for Mallows

Continuing the study of toxicity of antibiotics on plants a series of tests were made using mallow or broom weed (*Malvastrum coromandelianum* Garcke, det. J. Fishbeth).

For the tests the antibiotics (and other substances tested) were placed in 250 cc. of nutrient solution (8 grams of calcium nitrate, 2 grams of potassium nitrate, 2 grams of potassium acid phosphate, 2 grams of magnesium sulphate and a trace of ferric phosphate per ten liters of water). Four plants of mallow, each about four inches high, were left for eight hours in the solution before being planted in a garden plot. At the end of two weeks observations were made to see how many of each lot of specimens were alive.

The results of the tests are shown below, where an "\*" indicates a living plant and a "-" one that died. The quantity of the substance used is indicated in each case.

Control.....	* * * -
Sulfanilimide .1 g.....	* * * *
Homocysteine .2 cc. 5% solution.....	* * * *
Cystine hydrochloride .2 cc. 5% solution.....	* * * *
L-Cystine .2 cc. 5% solution.....	* * * -
D-L-Cystine .2 cc. 5% solution.....	* * * *
Folic acid 250 mg. <sup>1</sup> .....	* * * -
Dihydrocholic acid 50 mg. <sup>1</sup> .....	* * * -
Furacin 500 mg. <sup>1</sup> .....	- - - -
Furadroxyl 500 mg. <sup>1</sup> .....	* - - -
Furadantin 100 mg. <sup>1</sup> .....	* - - -
Terramycin 250 mg. <sup>2</sup> .....	- - - -
Dihydrostreptomycin sulphate .2 g. <sup>2</sup> .....	* * * *
Penicillin 200,000 units <sup>3</sup> .....	* * * -
Fumagillin and ascorbic acid 30 mg. each <sup>4</sup> .....	* * * *
Neomycin 500 mg. <sup>3</sup> .....	* * * -
PAA-701 250 mg. <sup>4</sup> .....	* * - -
Chloromycetin 250 mg. <sup>4</sup> .....	* - - -
Aureomycin 250 mg. <sup>5</sup> .....	- - - -
Newcastle virus 10 <sup>-1</sup> .5 cc.....	* * * *

<sup>1</sup>Courtesy of Eaton Laboratories.

<sup>2</sup>Courtesy of Chas. Pfizer & Co.

<sup>3</sup>Courtesy of Upjohn Co.

<sup>4</sup>Courtesy of Parke Davis & Co.

<sup>5</sup>Courtesy of Lederle Laboratories.

Most of the drugs tested are known to be only slightly toxic for animals, so that their toxicity for plants in some cases is rather surprising. Further testing should be done with different concentrations of the

drug. Obviously taking into account only whether a plant is killed or not and not considering the damage to living plants is a very crude measure of toxicity; however, for a rough screening of toxicity it seems the most practical. Each substance is toxic in a different way and the manifestations of the toxicity would be a study in itself.

#### IV. Toxicity of Some Substances for Bean Seedlings. 1. Part.

The author was interested in the toxicity of some common antibiotic substances on plants. For the test sprouting beans were used. For control nutrient solution alone and potassium permanganate solutions were used. The seed coats of the sprouting beans were removed and the radicals placed through holes punched in gauze covers of 250-cc. bottles, the bottles containing nutrient solution (6) and a quantity of the drug to be tested. Four bottles were used for each substance in the two dilutions used. Ten days after planting readings were made and the materials discarded.

The results are indicated in the table on page 137. Where the seedling died it is indicated in the table with a minus (-); where the seedling lived it is indicated with an asterisk: if the seedling was shrivelled without elongation of the epicotyl one asterisk, if the cotyledons were plump without elongation of the epicotyl, two (\*\*), if the plumule was expanded about an inch three asterisks (\*\*\*), if the plumule was expanded about three inches four asterisks (\*\*\*\*), if the plumule was expanded about six inches five asterisks (\*\*\*\*\*), and if the plumular portion was expanded over seven inches six asterisks (\*\*\*\*\*).

Of the seven substances tested two were strongly toxic and two stimulated growth and root production.

#### V. "Effects" of Some Substances on Mosaic of Mallows. 2. Part.

It was thought that the effect on a plant virus of some of the substances known or thought to have effects upon other microorganisms would be of some interest.

Since, at the time the tests were run, young plants of *Malvastrum corchorifolium* Britt. & Small showing marked mosaic infection were abundant, they were used for the tests.

For each control and to test each substance, four plants were dug, the roots were immediately washed and placed in 250-cc. bottles of nutrient solution (with the exception of the control placed in a 250-cc. bottle of distilled water). To test the substance, a dosage was placed in the bottle of nutrient solution<sup>1</sup> and three days later the dosage was duplicated. Three days later (that is, at the end of six days in nutrient solution) the plants were planted into pots of potting soil where they were observed for ten days at which time they were discarded.

In all twelve substances were tested. The substances tested and the results of the tests follow:

<sup>1</sup>The nutrient solution is composed of 8 grams of calcium nitrate, 2 grams of potassium nitrate, 2 grams of potassium acid phosphate, 2 grams of magnesium sulphate and a trace of ferric phosphate per ten liters of water.

*Control with distilled water only.*—Distilled water without nutrient salts was used. At the end of six days in the distilled water all four plants were alive, “thrifty” producing new roots, but with no change in

	Stronger Solution	Weaker Solution
Control (Nutrient solution only)	***** ***** ***** —	***** ***** ***** —
Furadantin <sup>4</sup> (50 mg. per bottle and 5 mg. per bottle)	***** ***** ***** ***	***** (roots ***** stimulated) ***** *****
Neomycin <sup>2</sup> (500 mg. per bottle and 100 mg. per bottle)	***** *** ***	***** *** —
Chloromycetin <sup>1</sup> (250 mg. per bottle 25 mg. per bottle)	** (chlorotic) — — —	— — — —
Chloromycetin and Dihydrostreptomycin <sup>1</sup> 250 mg. of each per bottle and 25 mg. of each per bottle	*** (chlorotic) ** (chlorotic) — —	*** (chlorotic) ** (chlorotic) — —
Aureomycin <sup>3</sup> (250 mg. per bottle and 25 mg. per bottle)	— — — —	— — — —
Potassium Permanganate 0.1 g. per bottle 0.01 g. per bottle	*** — — —	*** *** — —
Biosulfa <sup>2</sup> 500 mg. per bottle and 50 mg. per bottle	***** ***** ***** ****	***** (roots ***** strongly ***** stimulated) *****

<sup>1</sup>Courtesy of Park Davis & Co.

<sup>2</sup>Courtesy of Upjohn Co.

<sup>3</sup>Courtesy of Lederle Laboratories, Inc.

<sup>4</sup>Courtesy of Eaton Laboratories, Inc.

<sup>5</sup>Crystalline penicillin G. potassium 250,000 units, sulfadiazine .167 g., sulfamerazine .167 g. and sulfamethazine, .167 g.

the mosaic. At the end of ten days in the pots all four were healthy appearing except for the mosaic.

*Control with nutrient solution.*—At the end of six days in nutrient solution there appeared to be a slight lessening of the chlorosis of the



mosaic and new roots were developing. At the end of ten days in the pots all four were healthy appearing except for the mosaic.

*Penicillin*.—Nutrient solution with duplicated dosage of 200,000 units of penicillin (courtesy of the UpJohn Company, Kalamazoo, Michigan). At the end of six days in culture solution the chlorosis of the mosaic was unchanged, the roots were clean and new roots were being produced. By about the seventh day in soil all four were dead.

*Biosulfa*.—Nutrient solution with 50 mg. duplicated dosage of biosulfa (crystalline penicillin G. potassium 250,000 units, sulfadiazine 0.167 G. sulfamerazine 0.167 G., sulfamethazine 0.167 G., courtesy of the UpJohn Company). At the end of six days in culture in the solution the plants seemed less chlorotic but had fungus growing on the roots. At the end of ten days in potting soil two were dead, one was producing new leaves with mosaic and one was producing new leaves not showing mosaic.

*Terramycin*.—Nutrient solution with 250 mg. duplicated dosage of terramycin (courtesy of Chas. Pfizer & Co., New York) was used. The plants had increased chlorosis at the end of six days in culture solution and were in very poor condition. At the end of five days in potting soil they were completely dead.

*Chloromycetin*.—Nutrient solution with 250 mg. duplicated dosage of chloromycetin (courtesy of Parke, Davis & Co., Detroit, Mich.) was used. At the end of six days in culture solution the plants looked very bad and fungus was growing on the roots. After five days in potting soil two were dead and the remaining two appeared to be improved. At the end of ten days in soil three of the plants were dead and one was producing normal leaves.

*Neomycin*.—Nutrient solution with 500 mg. duplicated dosage of neomycin sulphate (courtesy of UpJohn Company, Kalamazoo, Michigan) was used. At the end of six days in culture solution the plants seemed less chlorotic and the roots were clean. At the end of ten days in soil two were dead and two were producing normal leaves.

*Fumagillin*.—Nutrient solution with duplicated dosage of 10 mg. of fumagillin and 10 mg. ascorbic acid (courtesy of the UpJohn Company, Kalamazoo Mich.) was used. At the end of six days in solution the plants seemed less chlorotic; while new roots were being produced the old roots were covered with fungi. At the end of ten days in soil all four were healthy appearing but only one was producing new leaves free of mosaic.

*Streptomycin*.—Nutrient solution with duplicated dosage of 250 mg. of streptomycin and 250 mg. of chloromycetin (courtesy of Parke, Davis & Co., Detroit) was used. At the end of six days in culture the chlorosis of the mosaic was much more prominent but the roots remained clean. After five days in potting soil one produced leaves not showing mosaic, but it and one other plant had died by the tenth day.

*Furadantin*.—Nutrient solution with duplicated dosage of 50 mg. of furadantin (courtesy of Eaton Laboratories, Inc., Norwich, N.Y.) was used. At the end of ten days in soil all four were alive but all producing new leaves showed mosaic.

*Potassium permanganate*.—Nutrient solution with a single dosage of 1 gram of potassium permanganate was used. At the end of six days in

culture solution the roots were clean and the chlorosis of the mosaic seemed unchanged. At the end of ten days in soil the new leaves showed *almost* no sign of mosaic.

*Aureomycin*.—Nutrient solution with a duplicated dosage of 250 milligrams of aureomycin was used. At the end of six days in culture solution all four of the plants were dead.

It will be seen that among plants treated by four of the substances at least one plant began to produce normal leaves: Biosulfa, Chloromycetin, Neomycin and Fumagillin. In each case the toxicity, however, appeared to be very high.

Further studies would be needed to see if the virus had actually disappeared or was only not showing its effects during the growth of the plants.

## VI. Toxicity of Some Substances for Bean Seedlings. 2. Part.

Continuing the study of the toxicity of some substances for bean seedlings a series of substances were placed in 250-cc. bottles of nutrient solution. Three concentrations of each substance were tested. Two germinating beans (before the plumule had expanded and with the seedcoat removed) were placed with their radicals through holes punched in the gauze covering the bottles so that the radicals were bathed in the liquid of the bottle. Ten days after planting readings were made and the materials were discarded.

The nutrient solution is composed of 8 grams of calcium nitrate, 2 grams of potassium nitrate, 2 grams of potassium acid phosphate, 2 grams of magnesium sulphate and a trace of ferric phosphate per ten liters of water.

The results are indicated in the following table. Where the seedling died it is indicated in the table with a minus (-); where the seedling lived it is indicated by asterisks: If the seedling was shrivelled without elongation of the epicotile one asterisk (\*), if the cotyledons was plump but without elongation of the epicotile two asterisks (\*\*), if the plumule was expanded about an inch three asterisks (\*\*\*), if the plumule was expanded about three inches four asterisks (\*\*\*\*), if the plumule was expanded about six inches five asterisks (\*\*\*\*\*), and if the plumular portion was expanded over seven inches six asterisks (\*\*\*\*\*). A cross (X) indicates good root development.

It will be noted from the results that there is usually a close correlation between development and root development or conversely apparent toxicity and inhibition of root production are closely related. At least three of the common antibiotics inhibit or reduce the capacity for normal chlorophyll production.

Solution	Strongest Solution	Medium Concentration	Weakest Solution
Control	***** ***** X	***** ***** X	***** ***** X
Hemocysteine (0.2 cc., 0.02 cc. and 0.002 cc. of 5% solution per bottle)	***** ***** X	***** ***** X	***** ** X
Cystine hydrochloride (0.2 cc., 0.02 cc. and 0.002 cc. of 5% solution per bottle)	***** ** X	***** ***** X	***** ***** X
L-Cystine (0.2 cc., 0.02 cc., 0.002 cc. of 5% solution per bottle)	***** *****	***** *****	***** ***** X
D-L-Cystine (0.2 cc., 0.02 cc. and 0.002 cc. of 5% solution per bottle)	***** ***** X	***** ***** X	***** *
Folic acid (250 mg., 25 mg. and 2.5 mg. per bottle) <sup>1</sup>	** *	***** ** X	***** ***** X
Dihydrocholic acid (50 mg., 5 mg. and 1 mg. per bottle) <sup>1</sup>	*** **	***** ***** X	***** ***** X
Furacin (1000 mg., 100 mg. and 10 mg. per bottle) <sup>1</sup>	** —	** **	** **
Furadroxyl (1000 mg., 100 mg., and 10 mg. per bottle) <sup>1</sup>	** —	— —	***** ***** X
Furadantin (200 mg., 20 mg. and 2 mg. per bottle)	***** *****	***** **	***** ***** X
Terramycin (1000 mg., 100 mg. and 10 mg. per bottle) <sup>2</sup>	* (chloro- — tic)	** (chloro- ** tic)	** (chloro- ** tic)
Dihydrostreptomycin sulphate (0.2 g., 0.02 g. and 0.002 g. per bottle)	*** **	***** *****	***** ***** X
Newcastle virus ( $10^{-1}$ .5cc, $10^{-1}$ .5 cc., $10^{-2}$ + 15 cc., $10^{-3}$ )	** —	** **	** **
Penicillin (500,000 units, 50,000 units and 5,000 units per bottle)	***** ***** X	***** ***** X	***** ***** X
Fumagillin and ascorbic acid (50 mg., 10 mg. and 2 mg. of each per bottle) <sup>3</sup>	*** (chloro- ** rotic)	*** —	***** *****
Neomycin (500 mg., 50 mg. and 5 mg. per bottle) <sup>3</sup>	** **	** **	** ** X
PAA-701 (500 mg., 50 mg. and 5 mg. per bottle) <sup>4</sup>	*** **	** **	***** ***** X
Chloromycetin (250 mg., 25 mg. and 3 mg. per bottle) <sup>4</sup>	*** (chlor.) **	**** (chlor.) ***	*** (chlor.) ***
Aureomycin (250 mg., 25 mg. and 3 mg. per bottle) <sup>5</sup>	* 3 (chlor.) —	** (chlor.) —	** (chlor.) **

<sup>1</sup>Courtesy of Eaton Laboratories.<sup>2</sup>Courtesy of Chas. Pfizer & Co.<sup>3</sup>Courtesy of Upjohn Co.<sup>4</sup>Courtesy of Parke, Davis & Co.<sup>5</sup>Courtesy of Lederle Laboratories.



## VII. "Effects" of Some Substances on Mosaic of Mallows.

### 2. Part.

Continuing the study of effects of antibiotics and other substances on mosaic of mallows, a series of tests were made using mallow or broom weed (*Malvastrum coromandelianum* Garcke det. J. Rishbeth).

For the tests 250 cc. bottles of nutrient solution, each (except the control) containing an additional substance, were used. To each bottle four plants of the mallow were placed. Each plant was about four inches high, and each strongly exhibiting mosaic disease. After being dug their roots were immediately washed. The plants were planted in a garden plot after eight hours in the test solution. At the end of two weeks, observations were made to see if the substance had any noticeable effect on the mosaic disease.

The nutrient solution is composed of 8 grams of calcium nitrate, 2 grams of potassium nitrate, 2 grams of potassium acid phosphate, 2 grams of magnesium sulphate and a trace of ferric phosphate per ten liters of water.

The results of the tests are shown below. In each instance the quantity of the substance tested is given. An "x" indicates the mosaic disease no longer was apparent in the new leaves being produced, '-' indicates a plant which the new leaves show the mosaic, while '.' indicates a dead plant.

Control.....	---
Sulphanilamide 500 mg.....	..
Homocysteine 0.2 cc. 5% sol.....	xx--
Cystine hydrochloride 0.2 cc. 5% sol.....	---
L-Cystine 0.2 cc. 5% sol.....	---
D-L-Cystine 0.2 cc. 5% sol.....	---
Folic acid 250 mg.....	---
Dihydrocholic acid 50 mg. <sup>1</sup> .....	---
Furacin 500 mg. <sup>1</sup> .....	..
Furadoxyl 500 mg. <sup>1</sup> .....	x..
Furadantin 100 mg. <sup>1</sup> .....	x--
Terramycin 250 mg. <sup>2</sup> .....	..
Dihydrostreptomycin sulfate .2 g. <sup>2</sup> .....	x---
Penicillin 200,000 units <sup>3</sup> .....	x--
Fumagillin and ascorbic acid 30 mg. <sup>3</sup> .....	x--
Neomycin 500 mg. <sup>3</sup> .....	---
PAA-701 250 mg. <sup>4</sup> .....	---
Chloromycetin 250 mg. <sup>4</sup> .....	--
Aureomycin 250 mg. <sup>4</sup> .....	..
Newcastle virus .5 cc 10 <sup>-1</sup> .....	xx--

<sup>1</sup>Courtesy of Eaton Laboratories.

<sup>2</sup>Courtesy of Chas. Pfizer Co.

<sup>3</sup>Courtesy of Upjohn Co.

<sup>4</sup>Courtesy of Parke Davis & Co.

<sup>5</sup>Courtesy of Lederle Laboratories.

While the substances tested showed great toxicity to the mallow several showed that they have some effect on control of the mosaic, indicating that there is the possibility of finding a substance which will control the virus without necessarily killing the plant in which it grows. For practical application, when such a drug is found there will be the necessity of finding a method of getting the drug into the plant by a more simple method than the one used.

## Further Studies in the Genus *Chlorococcum* Meneghini<sup>1</sup>

RICHARD C. STARR

(Department of Botany, Indiana University, Bloomington, Ind.)

In view of the illegitimacy of the genus *Chlorococcum* Fries (1825), Silva and Starr (1953) have proposed that the name *Chlorococcum* be conserved in favor of Meneghini (1842) who first described a species of the genus in light of its modern conception. The writer (Starr, 1953) reported on a comparative study of *Chlorococcum* Meneghini and other spherical genera of the Chlorococcaceae, emending the description of *Chlorococcum* Meneghini to include only those spherical chlorococcaceous algae which possess (1) zoopores with walls and two flagella of equal length, (2) vegetative cells with hollow spherical chromatophores and (3) vegetative cells with at least one pyrenoid. This report emphasized the "necessity for prolonged and periodic study, based on unialgal cultures, before new species and genera are described or old ones identified with certainty." Under conditions of culture similar to those in the above study, three other *Chlorococcum* isolations have been investigated; these are described in the following sections.

### CHLOROCOCCUM WIMMERI Rabenhorst

(Figures 1-6)

Among the algae present in the Culture Collection of Algae at Cambridge University is one designated as No. 213-4 which was isolated and identified by F. Mainx as *Chlorococcum Wimmeri* Rabenhorst. Examination of transfers of this alga and comparison of it with the description given by Rabenhorst (1868) presented again the problem of positive correlation of data obtained from algae in culture with that gained from less prolonged observations of naturally-occurring populations. Rabenhorst gives this description of the morphology of *C. Wimmeri*:

"Ch. cellulis magnis, singulis, globosis, pulcherrime coccinero-aurantiacis, lucidis; cytiodermate crasso lamelloso subachroo; cytoplasmate granuloso v.s."

As was pointed out earlier (Starr, 1953), a description such as this is hardly adequate for distinguishing a species of *Chlorococcum* from quiescent stages of other genera. The observation that the cells of *C. Wimmeri* contained a red-orange pigment and possessed a thick stratified cell wall might indicate that only old cells were seen. Orange or red pigments are commonly found in the old cells of a number of such species as *Haematococcus lacustris* (Girod.) Rostaf. and *Bracteococcus cinnabarinus* (Kol et F. Chodat) Starr. The pigment in the latter is dissolved in the oil which is stored as a reserve photosynthate; on the other hand, in *Haematococcus* the pigment is less intimately associated with the reserve photosynthate. Unfortunately Rabenhorst gave no clue as to which type of association was present in *C. Wimmeri*.

<sup>1</sup>This paper is part of a larger investigation of soil algae made possible through a grant from the Research Fund of the Graduate School of Indiana University.

In accordance with his earlier opinion (Starr, 1.c) to consider as uncertain the identity of most species of *Chlorococcum* until further investigations have been made of them in culture, the writer is redescribing the species, *C. Wimmeri*, basing his description on the culture (No. 213-4) which is identified as this species in the Culture Collection at Cambridge.

***Chlorococcum Wimmeri* Rabenhorst emend. Starr**

Cells ovoidal to spherical depending on age, reaching a maximum diameter of 45 microns. Cell wall smooth, thin, not thickening noticeably with age. Chromatophore a hollow sphere, in young cells with an opening on one side, in older cells the opening usually absent; chromatophore granular due to production of starch in large quantities. Pyrenoids many, increasing in number as cells enlarge. Cells uninucleate throughout development. Contractile vacuoles not observed. Characteristic orange-red pigment present in most cells of all ages; in some cells, pigment appears as a concentrated granular mass located centrally or nearly so; in others, the pigment is more diffuse and colors the cell either partially or completely.

Asexual reproduction by zoospores and aplanospores, formed by a series of successive bipartitions. Zoospores with walls and two flagella of equal length held recurved when at rest; 11 microns average length, 7.5 microns average width, variations of 1 to 2 microns not uncommon; anterior linear stigma; two contractile vacuoles; zoospore often containing orange-red pigment in anterior half.

Sexual reproduction not observed.

Although the organism under consideration appears to differ little from Rabenhorst's original description, except in not having a thick stratified wall, there is little actual proof that the present alga is the same which Rabenhorst described. The positive identification of a species must always depend on agreement of details; their absence can hardly be considered to serve the same purpose.

The cells of *C. Wimmeri* and *Haematococcus lacustris* are alike in pigmentation and in the presence of many pyrenoids in the chromatophore. Indeed, it is almost impossible to distinguish between the two algae when they are grown on agar media. In liquid media, however, *Haematococcus* assumes its characteristic motile state. This is further evidence of the necessity of growing such algae as the Chlorococcaceae in a variety of media and the need for observing them over a prolonged period.

That the vegetative cells are uninucleate was determined by observation of living material, for neither the iron alum haematoxylin nor the Feulgen method was successful. Apparently some substance which could not be readily removed by alcohol, xylol or ether prevented penetration of the fixative or the stain. *Chlorococcum Wimmeri* is maintained in bacteria-free culture on proteose and soil extract agars. No growth occurred when the alga was transferred to a mineral medium such as Bristol's agar.

***Chlorococcum vacuolatum* Starr, sp. nov.**

(Figures 7-10)

Cellulae ovatae vel sphaericae secundum aetatem, diametron maximum 40  $\mu$  attingentes. Tegumentum leve, aetate crassitudinem maxi-



mam  $3\mu$  attingens. Chromatophorus sphericus cavus, superficie interdum aliquantulum dissecta. Cytoplasma, in chromatophoro cavo inclusum saepe vacuolatum praecipue in cellulis juvenilibus laete crescentibus. Corpora crystallina in vacuolis cellularum juvenilium



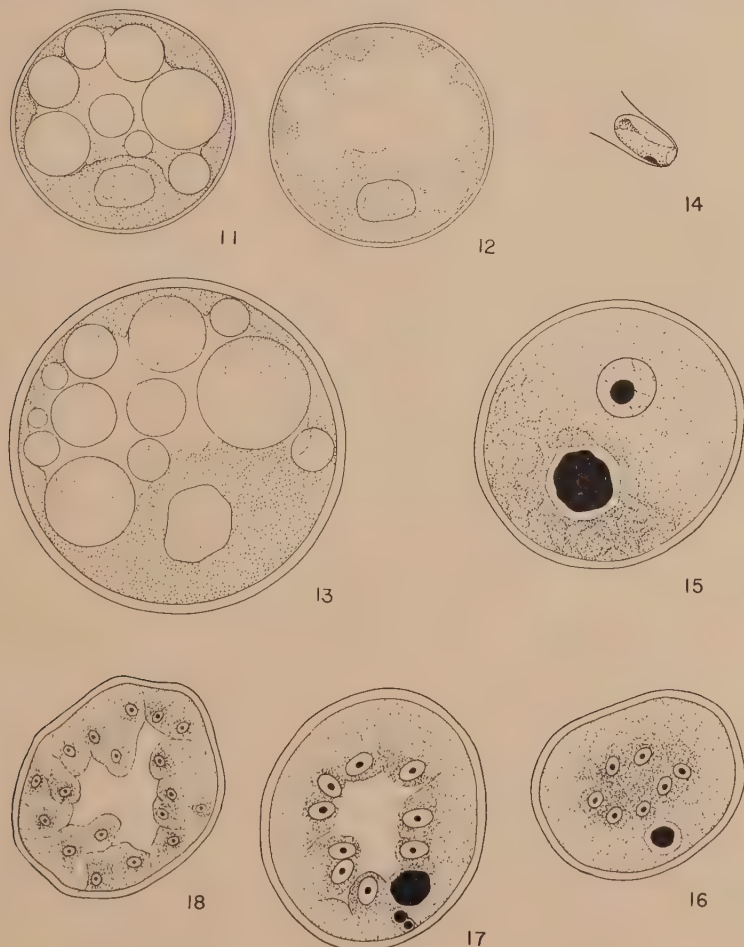
Figures 1-18 were drawn with the aid of a camera lucida. The approximate magnification is indicated after each species. All figures are from living material except where otherwise indicated.

FIGS. 1-6. *Chlorococcum Wimmeri* Rabenhorst.  $\times 1479$ . 1. Young vegetative cell, recently formed from zoospore. 2. Young vegetative cell showing granular pigment. 3. Older vegetative cell showing many pyrenoids and more diffuse pigment. 4. Successive bipartition of a sporangial cell. 5. Zoospore of the *Chlamydomonas* type. 6. Zoospore containing pigment.

FIGS. 7-10. *Chlorococcum vacuolatum* Starr sp. nov.  $\times 1479$ . 7. Surface view of vegetative cell. 8. Median optical section of same cell, showing vacuolated cytoplasm, single nucleus and pyrenoid; note two contractile vacuoles on periphery. 9. Median optical section of older vegetative cell. 10. Release of zoospores from a sporangial cell; note the gelatinous matrix in which they are embedded.

saepe praecipitata, et in cellulis vetustioribus manentia. Pyrenoideum unicum excentricum. Vacuolae pulsantes duae in peripheria cellulae in loco  $90^\circ$  a situ pyrenoidei. Cellulae uninucleatae per crescentiam. Amylum factum.

Propagatio asexualis per zoosporas atque aplanosporas, per bipartitionem successivam protoplasti formatas. Zoosporae e cellula matris per rupturam displodentem liberatae, in gelatina brevissime inclusae. Zoosporae ellipsoideae,  $9\ \mu$  longitudine mediocri,  $3\ \mu$  latitudine mediocri, variationibus  $1-2\ \mu$  quaque in dimensione non raris; Zoosporae vacuolas



FIGS. 11-18. *Chlorococcum macrostigmatum* Starr sp. nov.  $\times 1486$ . 11. Young vegetative cell showing vacuolated cytoplasm. 12. Vegetative cell of same size as in fig. 11, but showing the degeneration of the vacuoles in cytoplasm. 13. Large vegetative cell showing vacuolated cytoplasm. 14. Zoospore of the *Chlamydomonas* type. 15. Vegetative cell stained with IAH. 16. Stained cell showing result of successive nuclear divisions in preparation for cleavage. 17. Early stage of progressive cleavage in stained cell; note pyrenoid is still evident. 18. Later stage in cleavage, from stained cell; note pyrenoid is no longer evident.

pulsantes anteriores duas, flagella duo longitudine aequa recurvata dum quiescunt, stigmaque anterius mediocre praebentes; zoosporae tegumentis praeditae, non sphaericae factae dum quiescunt.

Propagatio sexualis non observata.

Cells ovoidal to spherical depending on age, reaching a maximum diameter of 40 microns. Cell wall smooth, increasing in thickness with age to a maximum of 3 microns. Chromatophore a hollow sphere the surface of which is at times slightly dissected. Cytoplasm, enclosed by hollow chromatophore, often vacuolate, especially in young actively growing cells. Crystalline bodies often precipitating in vacuoles of young cells and remaining in old cells. Pyrenoid single, excentric. Two contractile vacuoles on periphery of cell at a point  $90^\circ$  from location of pyrenoid. Cells uninucleate throughout development. Starch produced.

Asexual reproduction by means of zoospores and aplanospores, formed by the successive bipartition of the protoplast. Zoospores, released from mother cell by explosive rupture, embedded momentarily in gelatine. Zoospores ellipsoidal; 9 microns in average length, 3 microns in average width, variations of 1 to 2 microns in each dimension not uncommon; with two anterior contractile vacuoles and two flagella of equal length held recurved when at rest; with anterior stigma of medium size; zoospores with walls, not becoming spherical at quiescence.

Sexual reproduction not observed.

Source: soil from the Cape Flats, South Africa.

Culture Collection, Starr, No. Hp-1a.

The most striking characteristic of *Chlorococcum vacuolatum* is the vacuolate condition of actively growing cells. Upon casual examination it would appear that the chromatophore were a vacuolate structure similar to that found in *Protosiphon* (Bold, 1933), but careful study shows that the chromatophore is a hollow sphere enclosing a colorless mass of vacuolate cytoplasm in which the nucleus is embedded; this is indicated by the absence of any starch grains in the vacuolate area of the cell. As the cell ages and becomes filled with starch, the cytoplasm appears less and less vacuolate: the small crystals, which formed in the vacuoles of the young cells, often remain in the old cells even after vacuolation is no longer evident. The enclosing sphere of chromatophore substance is sometimes dissected in one or more areas. The single pyrenoid remains in an excentric position at all times.

It should be noted that the writer is aware that vacuolation may occur in algal cells grown under unfavorable conditions and that, therefore, this attribute might not be valid taxonomically. This is not the case in *C. vacuolatum*, for the vacuolated condition of the cells is at its height in cultures which are growing and multiplying very actively. A variety of liquid and solid media was used to ascertain whether some factor of the medium was causing this vacuolation, but the results were negative. The most critical factors influencing the appearance of vacuoles appear to be age of cells and intensity of illumination; both factors determine the amount of starch stored in the cells, the vacuoles being obscured by the presence of large amounts. *C. vacuolatum* is maintained in bacteria-free culture on Bristol's agar.

***Chlorococcum macrostigmatum* Starr, sp. nov.**

(Figures 11-18)

Cellulae ovatae vel sphaericae secundum aetatem, diametron maxi-



mum  $60\ \mu$  attingentes. Tegumentum leve, aetate non valde incrassatum. Chromatophorus sphericus cavus, superficie fortasse paululum dissecta, spatium cytoplasmicum liquidum in cellulis laete crescentibus saepe vacuolatum includens. In cellulis vetustioribus natura vacuolaris chromatophori per depositionem amyli celata. Pyrenoideum unicum, parietaliter inclusum. Vacuolae pulsantes non observatae. Cellulae usque ad fissionem uninucleatae.

Propagatio asexualis per zoosporas atque aplanosporas, per fissionem progredientem protoplasti formatas. Zoosporae in gelatina brevissime inclusae tempore liberationis per discidium membranae cellulae matris, ellipsoideae,  $7.5\ \mu$  longitudine mediocri,  $3\ \mu$  latitudine mediocri, variatione  $1\ \mu$  quaque in dimensione non rara; zoosporae habentes stigma valde perspicuum concavum prope extremitatem anteriorem, vacuolas pulsantes duas, et duo flagella longitudine aequa recurvata dum quiescunt. Zoosporae tegumentis praeditae, non sphaericae factae dum quiescunt.

Propagatio sexualis non observata.

Cells ovoidal to spherical depending on age, reaching a maximum diameter of 60 microns. Cell wall smooth, not increasing markedly with age. Chromatophore a hollow sphere, the surface of which may be slightly dissected. Hollow chromatophore is obscured by deposition of starch. Pyrenoid single, embedded in a parietal position. Contractile vacuoles not observed. Cells uninucleate until immediately preceding cleavage.

Asexual reproduction by means of zoospores and aplanospores, formed by the progressive cleavage of the protoplast. Zoospores momentarily embedded in gelatine at time of release by rupture of mother cell wall. Zoospores ellipsoidal, 7.5 microns in average length, 3 microns in average width, variation of 1 micron in each dimension not uncommon; with very prominent concave stigma near anterior end; with two contractile vacuoles and two flagella of equal length held recurved when at rest. Zoospores with walls, not becoming spherical at quiescence.

Sexual reproduction not observed.

Source: isolated from soil at the Osborn Botanical Laboratory, Yale University, No. Y-4.

Culture Collection, Starr, No. Y-4.

The structure of the vegetative cells in *Chlorococcum macrostigmatum* is very similar to that of *C. vacuolatum* described earlier in this paper. In both species, the cytoplasmic area of the cell appears vacuolate in actively growing individuals; in *C. macrostigmatum*, however, the vacuoles are usually smaller, more numerous and of a more temporary nature than those in *C. vacuolatum*. Although the vegetative cells of both species are uninucleate when mature, in *C. macrostigmatum* a series of successive mitotic divisions occurs immediately preceding cleavage, which is of the progressive type. The pyrenoid remains evident in the vegetative cell until after cleavage furrows begin to cut the protoplast into several parts. In later stages of cleavage the pyrenoid is no longer evident. Bold (1931) reported that in the progressive cleavage of *Chlorococcum infusionum* the pyrenoid fragmented, each subsequent division of the protoplast receiving a fragment. This was not observed in *C. macrostigmatum*.

The most striking characteristic of *C. macrostigmatum* is the presence of the large concave stigma on the anterior of the zoospore. No other species of *Chlorococcum*, examined by the writer, possesses zoospores with as large a stigma or one which remains in evidence as long after quiescence of the zoospore has occurred. *C. macrostigmatum* is maintained in bacteria-free culture on Bristol's agar.

#### DISCUSSION

The writer (Starr, 1953) considered as uncertain the identity of all previously described species of *Chlorococcum*, with the exception of *Chlorococcum infusionum* (Schrank) Meneghini sec. Bold 1931. This species was selected by Silva and Starr (1953) as the type for *Chlorococcum* Meneghini *nomen genericum conservandum propositum*. The following key to the species of *Chlorococcum* Meneghini emend. Starr lists all those species which the writer considers acceptable.

#### KEY TO SPECIES OF CHLOROCOCCUM MENEGHINI EMEND. STARR

1. Cells uninucleate at maturity. . . . . 2
1. Cells multinucleate at maturity. . . . . *C. multinucleatum* Starr (1953)
  2. Cells uninucleate throughout development; cleavage by successive bipartition. . . . . 3
  2. Cells uninucleate until immediately preceding zoosporogenesis by progressive cleavage. . . . . 7
3. Orange-red pigment present in most cells of all ages. . . . . *C. Wimmeri* Rabenhorst (page 143)
3. Pigment not present. . . . . 4
  4. Cell wall thickening with age. . . . . 5
  4. Cell wall not thickening with age. . . . . 6
5. Central cytoplasmic area vacuolate in actively growing cells. . . . . *C. vacuolatum* Starr (page 143)
5. Central cytoplasmic area not vacuolate. . . . . *C. minutum* Starr (1953)
  6. Spiny hypnospores produced in old cultures. . . . . *C. hypnosporum* Starr (1953)
  6. Spiny hypnospores not produced. . . . . *C. echinozygotum* Starr (1953)
7. Central cytoplasmic area vacuolate. . . . . *C. macrostigmatum* Starr (page 146)
7. Central cytoplasmic area not vacuolate. . . . . *C. infusionum* (Schrank) Menegh. (Bold, 1931)

#### SUMMARY

Three species of *Chlorococcum* Meneghini emend. Starr are described from unialgal cultures. *C. Wimmeri* Rabenhorst is redescribed based on transfers of a culture (No. 213-4) in the Cambridge Collection of Algae. Two new species, *C. vacuolatum* and *C. macrostigmatum*, were obtained from soil samples of South Africa and Yale University, respectively.

A key to the species of *Chlorococcum* Meneghini emend. Starr is given.

#### LITERATURE CITED

- Bold, H. C. 1931. Life history and cell structure of *Chlorococcum infusionum*. Bull. Torrey Bot. Club **57**: 577-604.
1933. The life history and cytology of *Protosiphon botryoides*. Bull. Torrey Bot. Club **60**: 241-299.
- Fries, E. M. 1825. Systema Orbis Vegetabilis. 374 pp. Lund.
- Meneghini, J. 1842. Monographia Nostochinearum Italicarum. Mem. Reale Accad. Sci. Torino II. **5**: 1-143.
- Rabenhorst, L. 1868. Flora Europaea Algarum. Vol. 3. 461 pp. Lipsiae.
- Silva, P. C., and Starr, R. C. 1953. Difficulties in applying the International Code of Botanical Nomenclature to certain unicellular Chlorophyceae, with special reference to *Chlorococcum*. Svensk Bot. Tid. **47**: 235-247.
- Starr, R. C. 1953. A comparative study of *Chlorococcum* Meneghini and other spherical, zoospore-producing genera of the Chlorococcales (to be published).

## Studies on Spirostreptoid Millipeds.

### I. The Genus *Isoporostreptus* Silvestri

RICHARD L. HOFFMAN

(Clifton Forge, Virginia)

In 1909 the late R. I. Pocock observed that “. . . the nomenclature of the Neotropical genera of this family [Spirostreptidae] is in a state of confusion . . .” He provided a careful analysis of the situation insofar as regards the names involved in the Central American fauna, and it is a matter of regret that most of his contemporaries and successors have not been so painstaking. I have remarked elsewhere that it is now almost necessary for one to revise a family before feeling safe in describing a new species, because of the conditions generally prevailing in recent diplopod taxonomy. The family Spirostreptidae is no exception, although it has been the subject of two long papers (Attems 1914 and 1950). It is well known that Attems' taxonomic philosophy was one of remarkable conservatism. It is felt that much of the existing confusion in many milliped groups is due partly to his long-standing practice of fitting as many species into as few genera as possible.

The present paper is part of an attempt to achieve some degree of stability in the classification of certain American milliped groups. Ideally the best approach would be the revision of an entire family. But such an undertaking is next to impossible at the present time for lack of adequate material. Therefore it is necessary to attack the problems piecemeal, by genera. C. A. W. Jeekel has recently set a standard for this sort of work with his study of the East Indian genus *Tectoporus*, based on specimens at hand supplemented by information available in the literature. Jeekel has also pointed out the importance of dealing with serial homologies as regards the male genitalia, an approach sadly neglected by most recent taxonomists. It is moreover a matter of regret that certain workers neglected to consult the papers of their predecessors, with the result that many synonyms now require attention and disposal.

In the past, and originating chiefly with Silvestri, a great deal of emphasis has been laid upon the presence or absence of pores on the 5th segment as a character of generic importance. From the evidence which I have seen, however, I am convinced that this character has no phylogenetic significance, that is to say, the place of origin, of the pore series is not correlated with the more fundamental genital features, nor in any case do “genera” so distinguished seem to have any sort of regular distribution. Furthermore, as Pocock points out, in those cases where the pores are small it is often very difficult to detect them readily, and I would suspect that more than once errors have resulted from this particular. I therefore follow Brolemann and Pocock in regarding the presence or absence of pores on the 5th segment as a specific character. In general the male gonopods afford the only real basis for generic recognition.



For assistance rendered during the preparation of this paper I am grateful to the following individuals: Dr. E. A. Chapin, for access to the collections of the U. S. National Museum; Mr. H. F. Loomis, for the loan of reference material and for reading the manuscript; and Dr. Otto Schubart, for several useful suggestions. The staff of the Virginia Polytechnic Institute Library has been most helpful in obtaining microfilm copies of certain scarce references.

### Genus ISOPOROSTREPTUS Silvestri

*Isoporoastreptus* Silvestri, 1898, Ann. Mus. Nac. Buenos Aires, 6: 73.

*Epistreptus* (non Silvestri) Carl, 1914, Mem. Soc. neuchatel. Sci. nat. 5: 865.

*Pemptoporus* Attems, 1914, Zoologica 25 (65/66) 121.

*Scaphioastreptus* (non Brelemani) Attems, 1950, Ann. Naturh. Mus. Wien 57: 230, 236 (in part).

*Type*.—*Isoporoastreptus villicola* Silvestri.

*Diagnosis*.—Exospermite of posterior gonopod distally laminate and shielding the solenomerite as in *Orthoporus*; femoral process as long as exospermite and frequently expanded distally; no other spines, processes, or teeth present. Distal extremity of anterior gonopod only slightly enlarged and lacking well-defined "lateral cones" as found in most species of *Orthoporus*.

*Distribution*.—Andine region of Ecuador, Colombia, and Panama.

*Synonymy*.—It is interesting that such a small genus would have so many incorrect names. These may be attributed in part to Silvestri's preoccupation with external characteristics in generic diagnosis, and in part to Attems' failure to recognize obvious lines of affinity in dealing with the species involved.

Carl's usage of *Epistreptus* for this genus (1914: 865) came about in the following manner: presumably relying upon details of segmental sculpture for distinction, Silvestri had previously (1898) described one Colombian species under the name *Epistreptus ehlersi* and another as *Isoporoastreptus villicola*. Carl re-examined the type specimen of the former, found the genitalia to be very similar to those of *villicola*, and properly concluded that the two were congeneric. His error lay in assuming that *ehlersi* was referable to *Epistreptus* as characterized by the type species, *oscenus* Silv., 1897. Actually the genitalia of *E. oscenus* are of a type which is not, to my knowledge, closely duplicated elsewhere in the spirostreptoids. At any rate *oscenus* can not be regarded as a congener of either *ehlersi* or *villicola*.<sup>1</sup>

*Pemptoporus* was based by Attems upon another Silvestrian species, originally described under the name *Diaporus augur*. The figure of the genitalia given by Silvestri, herewith reproduced as figures 1 and 2 leave no doubt that *augur* is to be allocated to *Isoporoastreptus*, the location of the repugnatorial pores notwithstanding. The occurrence of *augur* in Ecuador falls into line with the range of the other species as presently known. Attems' most recent paper (1950: 224) cites his later genus *Nesostreptus* as a synonym of *Pemptoporus*. This association is incorrect. Jeekel has recently shown (1952: 74) that *Nesostreptus*

<sup>1</sup>My evaluation of *Epistreptus* results in monotypy, and will require the reallocation of the dozen or more African species which Attems has placed in the genus.

is the proper name for the South American species heretofore called *Alloporus*, none of which are at all similar to *augur* in gonopod features.

Finally, mention must be made of one outstanding menace to the nomenclatural stability of this genus. This is the name *Urotropis* of Silvestri, based upon *Spirostreptus carinatus* Porat from West Africa. The illustration which Porat gives of the gonopod of *carinatus* (1894, Bih. Till. Sv. Vet.-Akad. Handl., 20, pt. 4, no. 5, pl. 5, fig. 50) is very much like those of the species of *Isoporoastreptus*, to the extent of strongly suggesting congeneric position. The only differences which set *carinatus* off from the South American forms are (1) a small lobed process at the base of the exospermite of the gonopod, (2) the setose appearance of the distal end of the anterior gonopods, and (3) the compressed and carinate nature of the anal tergite. The first two distinctions might well be supported by a restudy of the type specimen. Pocock has expressed the belief that the last character is doubtless one of specific rather than generic value, an opinion in which I concur. Still it seems unlikely that a small genus would be represented in two areas as faunally unlike as the Andes and West Africa. Until positive evidence comes to hand, I prefer to retain Silvestri's name for our New World group of species.

*Species*.—Seven, one of which is here described for the first time.

### *Isoporoastreptus pittieri*, new species

Figures 6, 7

*Type specimen*.—Adult male, U. S. Nat. Mus. no. 2018, from Los Sigüas, Province of Chiriqui, Panama; collected by Henri Pittier on March 17, 1911.

*Diagnosis*.—A species of the *villicola-ruralis* group (see discussion below), characterized primarily by the shape of the male gonopods. The "exospermite" of the posterior gonopod is only slightly curved, being bent at a right angle at about its midlength in contrast to the sigmoidally flexed exospermite of *ruralis* and the strongly recurved one of *villicola*. The femoral process is much broader in *pittieri*, and bent twice at right angles at its distal third. The paragonocoele of the anterior gonopods is distally attenuate and spiniform in *ruralis*, broadly rounded in *villicola*, and only acutely pointed in *pittieri*. Ample differences in shape and proportion may be observed in the drawings given.

*Description*.—The following notes were made from the type specimen: length, about 74 mm (specimen broken), width, 4.5 mm. Number of segments, 49, the last legless.

Head: interocular area smooth; frons vertically wrinkled, clypeus with about 10 deep vertical scratches; about 18 labral pores, these more or less elongate. Ocelli in distinctly reniform patches, concave next the antennal sockets, narrowing mesially, in 5 transverse rows as follows (front to back): 5-7-9-10-10. Area below ocelli strongly striate-sulcate.

Collum smooth, its anteriorlateral angle produced cephaloventrad, with four deeply impressed unbranched grooves.

Body segments: tergites essentially smooth, very finely coriaceous under magnification, prozonites with five or six very fine parallel

encircling ridges; interzonal furrow smooth but with many short and fine longitudinal carinae; metatergite somewhat raised above level of prozonite and slightly more coriaceous. Pleurites becoming increasingly striate or carinate below, the raised portions terminating distally in pronounced projecting knobs, about 12 on each side, these becoming obsolete toward the rear of the animal.



FIG. 1. *Isoporostreptus augur*, left gonopods, anterior aspect (from Silvestri 1897). FIG. 2. The same, right posterior gonopod, anterior aspect (from Silvestri 1897). FIG. 3. *I. drepanophorus*, left gonopods, anterior aspect (from Attems 1950). FIG. 4. *I. ehlersi* (Silvestri), left gonopods, anterior aspect (from Carl 1914). FIG. 5. *I. hererothyreus* (Karsch), left gonopods, anterior aspect (from Carl 1914).



Anal segment: robust, coriaceous, not exceeding the anal valves, its ventral portion slightly lobed in front of them (giving the impression of a preanal scale), the margin of this portion with short radiating striae. Anal valves with their mesial margins very greatly inflated, and set off by an unusually deep adjoining groove. Anterior half of each valve flat and somewhat wrinkled.

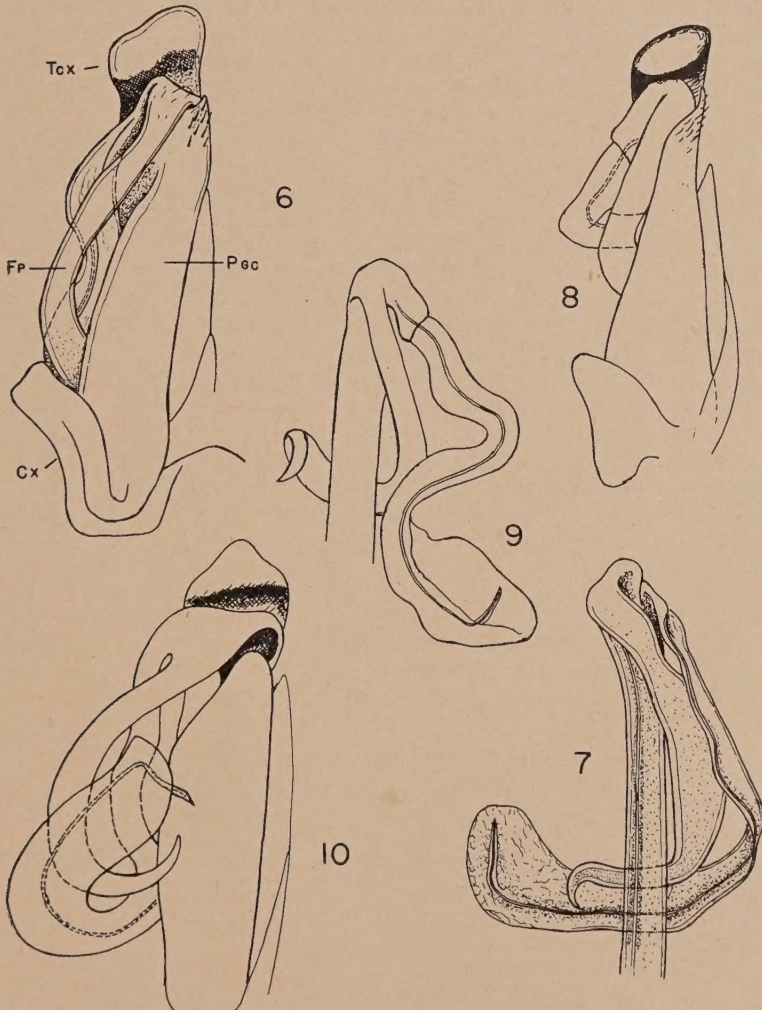


FIG. 6. *Isoporostreptus piltieri*, left gonopods, anterior aspect (Cx, coxite; Fp, femoral process of posterior gonopod; Pgc, paragonocoele; Tcx, telocoxite). FIG. 7. The same, right posterior gonopod, anterior aspect. FIG. 8. *I. ruralis* left gonopods, anterior aspect (from Carl 1914). FIG. 9. The same, right posterior gonopod, anterior aspect (from Carl, 1914). FIG. 10. *I. villicola*, left gonopods, anterior aspect (from Carl, 1914).

Sternites quadratic in shape, smooth, with the caudal margins produced into a small median lobe in front of the leg pair of the following segment. Legs stout, glabrous, but with a strong bristle at the end of joints 1, 2, and 3 on the ventral side; joints 4 and 5 without bristles but with the usual membranous pads; joint 6 with 2 ventral bristles and one above and one caudad to the base of the long, nearly straight tarsal claw. Coxae of legs broadly in contact.

First legs of male five-jointed distad of coxosternum, prefemora rectangular, without any trace of prefemoral processes, femora strongly clavate distad, postfemora with three ventral bristles, tibiae with one, tarsi elongate with a small circle of setae at the base of the claw, which is nearly equal in length to the tarsal joint.

Gonopods as represented in figures 6 and 7. Paragonocoel (*pgc*) elongate, rather narrow, subparallel-sided, terminating distally in a short acumen. Telocoxite (*tcx*) very slightly enlarged distally, without any trace of a lateral cone; coxite (*cx*) somewhat less than half the length of the paragonocoel. Posterior gonopods elongate, the telopodite gradually becoming broadly laminate distally, curving around behind the anterior pair and overlapping the end of the other gonopod. Femoral process nearly as long as telopodite, and broadest at its midlength; bent twice at right angles near its distal end.

Specimen discolored from long preservation, so that no statement can be made regarding its color in life.

This species is named for its collector, Dr. Henri Pittier, an outstanding pioneer in the study of tropical American botany. The large number of Central American millipeds in the collection of the U. S. National Museum collected by Pittier attest to his diligence and wide interest in natural history.

In addition to *pittieri*, six other species are at present definitely referable to this genus. Certain others from northwestern South America, based upon female specimens, may also belong here.

#### ISOPOROSTREPTUS AUGUR (Silvestri)

*Diaporus augur* Silvestri, 1897, Boll. Mus. Torino, **12** (305): 5, figs. 14, 15.

*Pemptoporus augur* Attems, 1914, Zoologica, **25** (65/66): 121.

Type locality.—Valle del Santiago, eastern Ecuador.

Range.—Known only from the type locality.

#### ISOPOROSTREPTUS DREPANOPHORUS (Attems)

*Scaphiostreptus drepanophorus* Attems, 1950, Ann. Naturhist. Mus. Wien **57**: 236, 237, figs. 63-65.

Type locality.—Cauca Valley, Colombia.

Range.—Known only from the type locality.

#### ISOPOROSTREPTUS EHLERSI (Silvestri)

*Epistreptus ehlersi* Silvestri, 1898, An. Mus. Nac. Buenos Aires **6**: 74.—Carl, 1914, Mem. Soc. neuchatel. Sci. nat. **5**: 867, 868, fig. 82.

*Scaphiostreptus ehlersi* Attems, 1950, *op. cit.*, p. 230.

Type locality.—Mine Purnio, Colombia.

Range.—Recorded from the type locality and Honda, Buenavista, and Guadua, Colombia.



## ISOPOROSTREPTUS HETEROTHYREUS (Karsch)

*Spirostreptus heterothyreus* Karsch, 1881, Zeitschr. Naturwiss. 54: 32.—Carl, *op. cit.*, p. 868, figs. 83, 84.

*Scaphiostreptus heterothyreus* Attems, 1950, *op. cit.*, p. 227.

Type locality.—Santa Martha, Colombia.

Range.—Known only from the type locality.

## ISOPOROSTREPTUS RURALIS (Carl)

*Spirostreptus (Epistreptus) ruralis* Carl, 1914, *op. cit.*, p. 865, figs. 79, 80.

Type locality.—La Camelia, 1800 m., Colombia.

Range.—Recorded from La Camelia, Jiradot, and Puerto de los Pobres, Colombia.

## ISOPOROSTREPTUS VILICOLA (Silvestri)

*Isoporoastreptus villicola* Silvestri, 1898, *op. cit.*, p. 73.

*Spirostreptus (Epistreptus) villicola* Carl, 1914, *op. cit.*, p. 867, fig. 81.

Type locality.—Villavicencio, Colombia.

Range.—Known only from the type locality.

By the configuration of the paragonocoel of the anterior gonopods,<sup>2</sup> the species of *Isoporoastreptus* may be conveniently divided into two subgeneric groups. Following this separation further discrimination of species is made, chiefly, by appeal to the shape of the posterior gonopods (see the following key).

By analogy with other and much better-known animal groups, we may safely predict, upon the basis of the small number of species presently known from within the generic range of *Isoporoastreptus* and the relatively few places within this range where millipeds have been collected, that a large number of species remain to be accounted for. In the hope of facilitating the description and evaluation of these forms, I am providing, in addition to a key to the known species, reproductions of the illustrations of their genitalia. Reference to these will reveal certain obvious lines of affinity, *viz.*, close relationship between *heterothyreus* and *drepanophorus*, and between *pittieri* and *ruralis*. Perhaps the relationship in these cases will turn out to be only subspecific; perhaps, in addition, annectant forms will be found to close the gap between the two groups herein recognized.

## KEY TO THE SPECIES OF ISOPOROSTREPTUS

1. Paragonocoel distally becoming narrower, its outer distal portion overlapped and concealed by the femoral process of the posterior gonopod (*Villicola* Group)..... 2
- Paragonocoel not smaller distally, and with a prominent lateral flange or lobe which overlaps the basal portion of the femoral process (*Ehlersi* Group)... 4
2. Paragonocoel widest at its midlength; distally rounded (fig. 10)..... *villicola* Silvestri
- Paragonocoel widest at base, distally acuminate (figs. 6 and 8)..... 3
3. Tibiotarsus of posterior gonopod strongly sigmoid, it and the femoral process of about the same width through most of their lengths (fig. 9)... *ruralis* Carl
- Tibiotarsus of posterior gonopod not sigmoidally twisted; femoral process becoming expanded about its midlength (fig. 7)..... *pittieri* new species

<sup>2</sup>Attems and Brolemann have produced convincing evidence that the so-called "posterior gonopods" are in actuality the telopodite elements of the "anterior pair" which are the coxopodites. For the purposes of this paper I use "posterior gonopod" merely for convenience.



4. Lateral lobe of paragonocoel very large, overlapping base of tabiotarsus as well as that of femoral process..... 5  
Lateral lobe of paragonocoel of small to moderate size, overlapping only base of femoral process..... 6
5. Distal end of telocoxite broadly expanded and enlarged; femoral process broad and spatulate..... *heterothyreus* (Karsch)  
Distal end of telocoxite evenly rounded, not differentiated; femoral process long and slender, tapering gradually distad..... *drepanophorus* (Attems)
6. Paragonocoel short and broad, constricted at midlength, distally rounded and lobed; telocoxite with a rudimentary lateral cone; distal end of tibiotarsus of posterior gonopod not exceptionally broadened..... *augur* (Silvestri)  
Paragonocoel longer and more slender, not constricted, distally acuminate; tibiotarsus of posterior gonopod broadly spoon-shaped..... *ehlersi* (Silvestri)

Aside from the seven species treated in this summary, several others (known only from the female sex) may actually be found to belong here, such as *S. chirographus* Karsch 1881 and *E. eustriatus* Chamberlin 1923.

#### LITERATURE CITED

- Attems, Carl G.** 1914—Die Afrikanischen Spirostreptiden, nebst Ueberblick über die Spirostreptiden orbis terrarum. *Zoologica* (Stuttgart) **25** (65–66): 1–235.  
1950—Über Spirostreptiden (Diplopoda). *Ann. Naturhist. Mus. Wien* **57**: 179–257.
- Carl, J.** 1914—Die Diplopoden Columbiens nebst Beiträgen zur Morphologie der Stemmatoiluliden. *Mem. Soc. neuchatel. Sci. natur.* **5**: 821–993.
- Chamberlin, R. V.** 1923—Results of the Bryant Walker Expedition of the University of Michigan to Colombia, 1913, and British Guiana, 1914. The Diplopoda. *Occ. Pap. Mus. Zool. Univ. Michigan* **133**: 1–143.
- Jeekel, C. A. W.** 1952—Milliped Miscellany. *Entom. Bericht* **14**: 71–77.
- Karsch, F.** 1881—Neue Juliden des Berliner Museums als Prodrömus einer Juliden-Monographie. *Zeitschr. Naturwiss.* **54**: 1–79.
- Pocock, R. I.** 1895–1910—*Biologia Centrali-Americana. Zoologia. Chilopoda and Diplopoda.* pp. 1–217. Taylor and Francis, London.
- Porat, C. O.** 1894—Zur Myriapodenfauna Kameruns. *Bihang Sven. Vet.-Akad. Handl.* **20**, section 4, no. 5: 1–90.
- Silvestri, F.** 1897—Viaggio del Dr. E. Festa nell Ecuador et regione vicine. V. Chilopodi e Diplopodi. *Boll. Mus. Torino* **12** (305): 1–18.  
1898—Diagnosticos de nuevos Diplopodos Sudamericanos. *Anal. Mus. Nac. Buenos Aires* **6**: 53–79.